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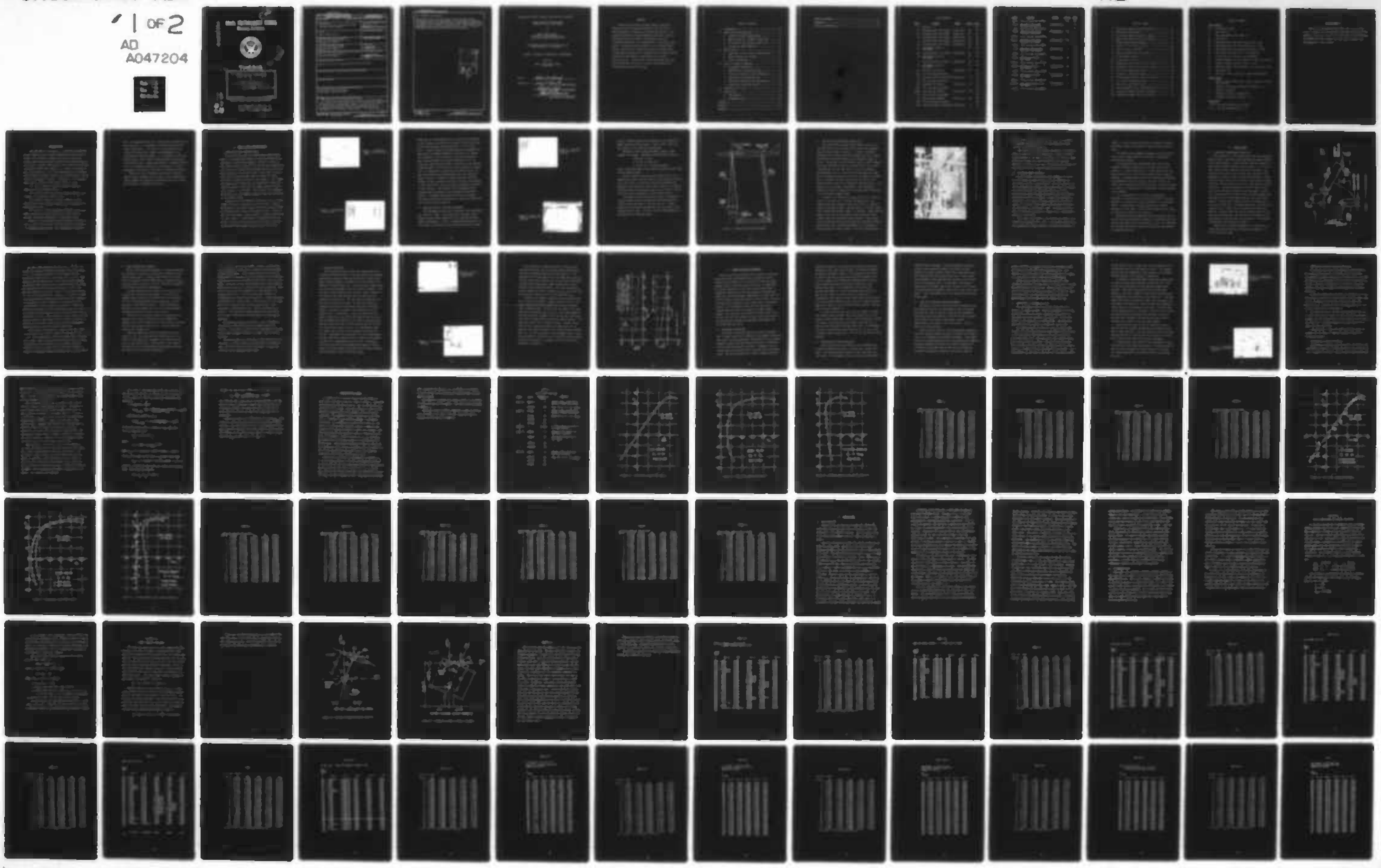

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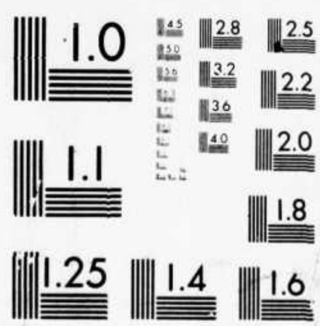


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# NAVAL POSTGRADUATE SCHOOL
## Monterey, California



(9) Masters THESIS

(6) Design Study of a Centerplate Mount for Wind Tunnel Models.

by

(10) Robert Wayne/Russell

(11) June 1977 (12) 113 p.

Thesis Advisor: L. V. Schmidt

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| REPORT DOCUMENTATION PAGE | | READ INSTRUCTIONS BEFORE COMPLETING FORM |
|---|---|---|
| 1. REPORT NUMBER | 2. GOVT ACCESSION NO. | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle) Design Study of a Centerplate Mount for Wind Tunnel Models | | 5. TYPE OF REPORT & PERIOD COVERED Master's Thesis June 1977 |
| | | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s) Robert Wayne Russell | | 8. CONTRACT OR GRANT NUMBER(s) |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, CA 93940 | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS |
| 11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, CA 93940 | | 12. REPORT DATE June 1977 |
| | | 13. NUMBER OF PAGES 113 |
| 14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Naval Postgraduate School Monterey, CA 93940 | | 15. SECURITY CLASS. (of this report) UNCLASSIFIED |
| | | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Wind tunnel mounting system
Aerodynamic tare evaluation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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# Design Study of a Centerplate Mount for Wind Tunnel Models

by

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Lieutenant, United States Navy
B.S.A.E., Purdue University, 1971

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
June 1977

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# ABSTRACT

A three-strut wind-tunnel model support system was being used with an electrical balance in the 3.5 by 5.0 foot Department of Aeronautics low-speed wind tunnel. The traditional method of image systems and alternate inverted mounting for the evaluation of aerodynamic tares was considered impractical for implementation in the small sized tunnel. The design and installation of an alternate model support system using a centerplate mount was accomplished. An aerodynamic evaluation for comparing the two model mounting concepts was performed via experiments with a single calibration wing. Additionally, these experiments were the first operational exercise of a recently developed micro-processor data acquisition system.

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### Latin Symbols

| | |
|---|---|
| A.C. | Aerodynamic center |
| $c$ | Wing chord ft |
| $\bar{c}$ | Mean aerodynamic chord (MAC), ft |
| $\mathrm{C_L}$ (℄) | Centerline |
| $C_D$ | Non-dimensional drag force coefficient = D/QS |
| $C_L$ | Non-dimensional lift force coefficient = L/QS |
| $C_M$ | Non-dimensional pitch moment coefficient = M/QSc |
| D | Drag force, lbs, positive in aft direction |
| L | Lift force, lbs, positive in up direction |
| M | Pitching moment, ft-lbs, positive in nose up direction |
| Q | Dynamic pressure, lbs/ft$^2$ (PSF), = $\frac{1}{2} \rho V^2$ |
| $R_N$ | Reynolds number, non-dimensional, for the wing = $\rho Vc/\mu$ |
| S | Wing area, ft$^2$ |
| V | Velocity, ft/sec, positive in downstream direction |

### Greek Symbols

| | |
|---|---|
| $\alpha$ | Angle of attack (AOA), deg. or rad., positive in nose up direction |
| $\Delta$ | Change in position or specified variable, $\Delta(\ )$ |
| $\rho$ | Density, slugs/ft$^3$ |
| $\mu$ | Absolute viscosity, slugs/ft-sec |
| $\nu$ | Kinematic viscosity, ft$^2$/sec = $\mu/\rho$ |

### Subscripts

| | |
|---|---|
| $(\ )_{\bar{c}/4}$ | Variable referenced to 0.25 MAC |
| $(\ )_o$ | Variable evaluated at $C_L = 0$ |

# ACKNOWLEDGMENT

The sincere gratitude of the author goes to Professor Louis V. Schmidt for his patience, knowledge and professional example. Additional thanks go to technicians Glenn Middleton, Ron Ramaker and Stan Johnson for their help, interest and craftsmanship in the project.

# I. INTRODUCTION

The Department of Aeronautics at the Naval Postgraduate School (NPS) has seen limited low-speed wind-tunnel work in either its curricula or student research over the past several years despite housing several fine low-speed tunnels. The tunnel of primary interest was built to NPS specifications and design by West Coast Research. It offers an octagonal test section with 3.5 by 5.0 foot measurements and a maximum tunnel operating dynamic pressure (Q) of approximately 100 psf from its two-stage fan section. Although it is an excellent small tunnel, several factors have limited its use;

(1) Lack of modern, electronic balance capable of supplying analog voltage signals,

(2) Lack of a data acquisition system to convert analog voltage into convenient digital form,

(3) Lack of a potential computer program for the calculation of wall correction factors for an arbitrary wing configuration, and

(4) Lack of a flexible mounting system that would ease model construction, allow rapid model or configuration changes, and enable measurement of aerodynamic tares.

Recently, an improvement program has been initiated to correct the limiting factors with the objective of producing an integrated tunnel system. Work documented by Concannon in

Ref. 1 has removed factor one. Current work by Casko, Ref. 2, and Heard, Ref. 3, is projected to remove factors two and three, respectively. This thesis is a design study for a solution to factor four, namely, the development of an improved model mounting system. It is important to note the balance system lends itself to three-component longitudinal airframe data, only. Downstream planning is needed to acquire a full six-component balance facility capable of yielding aerodynamic information at both angle of attack and sideslip.

Completion of the integrated system should provide a modern, highly automated tunnel system, readily adaptable to various demands and capable of generating accurate airframe data suitable for engineering analysis.

# II. MOUNT DESIGN CONSIDERATIONS

## A. THREE-STRUT MOUNT PROBLEM AREAS

The three-strut mount has traditionally found great favor in low-speed wind tunnels for testing conventionally configured, nonaeroelastic models. As seen in figure 1, the three-strut mount consists of two main struts supporting the wing at two wing station attachment points, and a third strut attached to an aft tail sting. This type of mount is sufficiently rigid and offers ease of angle of attack variation, as pointed out on pg. 149 in Ref. 4. For larger low-speed tunnels, drag tare and interference evaluation is possible; however, the three-strut model support system is quite complex in this regard. Small tunnel size compounds the problem and most academic tunnels forego the evaluation of aerodynamic tares.

Exposed struts contribute a drag tare and/or a pitching moment variation in the case of the aft strut. Partial compensation is possible through the use of strut fairings or windshields over some of the exposed struts. Strut to fairing interference, though present, is usually negligible in small tunnels. A more serious interference effect is that of the wing strut and fairing on the wing, inducing unknown flow disturbances onto the wing's flow field.

Figure 1. Three-strut mount and calibration wing.

Figure 2. Wing attach point detail.

Techniques for the evaluation of this effect are documented in the literature and utilize a procedure involving an image system and alternate inverted mounting; cf, pp. 175-180, Ref. 4. Figure 2 depicts the requirement for extremely fine image detail and model hardware to facilitate this scheme. The investment in time and detail is usually by-passed in small tunnels because of the small absolute size of the correction sought and the inherent resolution of the balance system employed. The third strut varies the angle of attack, and it is reasonable to assume that an unfaired strut will contribute drag and pitching moment tares as a function of angle of attack. Elaborate, variable fairings have been devised to keep the exposed portion of the aft strut constant in some large tunnels, but aft struts are generally unfaired in small tunnels. Additionally, wing attachment points preclude model experiments for investigating aeroelastic effects. A mounting system which would relax the above restrictions within the limitations of the tunnel balance and test section area was required.

B. MODIFIED TASK MK I BALANCE LIMITATIONS

The Department of Aeronautics acquired a Task Corporation MK I balance in 1958. The balance was a standard, three-component beam balance capable of lift, drag and pitching moment measurements. In Ref. 1 Concannon describes modifications made to the balance to provide electrical strain gage

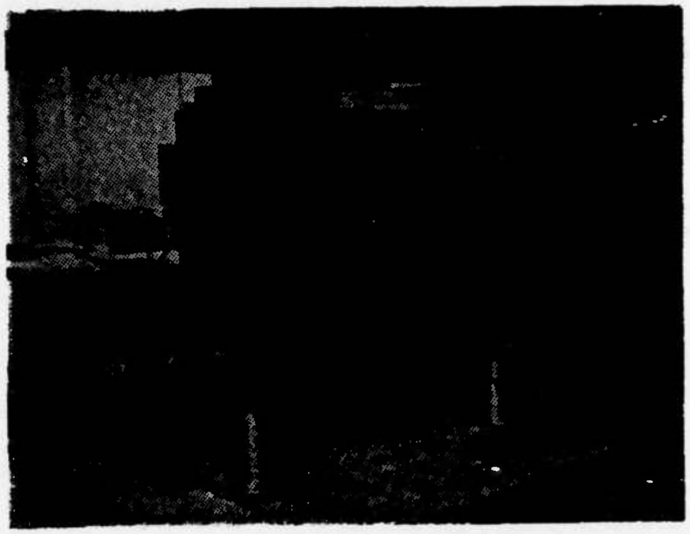


Figure 3. Left side modified Task MK I balance.

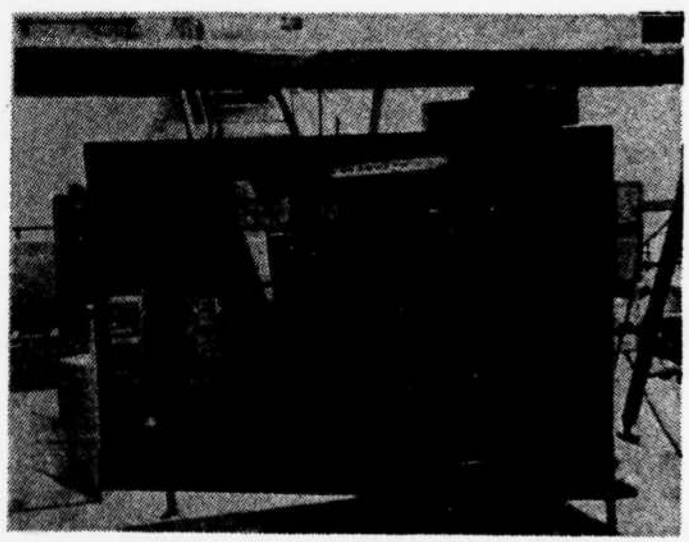


Figure 4. Right side, modified Task MK I balance.

outputs, thereby upgrading its potential as an element of a modern data acquisition system. Figures 3 and 4 show the Task balance in its modified configuration.

Adoption of strain gage measurement imposes linear response load ranges. Concannon selected these ranges as;

$\pm$ 500 lbs. in lift,

$\pm$ 75 lbs. in drag, and

$\pm$ 75 ft.-lbs. in pitching moment

These values were taken as the expected maximum working loads for the proposed mount.

Figure 4 depicts the large cross beam for main strut support and a small aft lever arm for varying angle of attack via a tail strut. As would be supposed, the balance was designed for a three-strut mount shown previously in figure 1. The provisions for main beam support and aft angle of attack drive had to be incorporated in the proposed design.

The balance is also configured so that the geometry of a parallelogram had to be established and maintained for constant one-to-one angle of attack tracking. Figure 5 depicts the relationship between the lever arm pivot, main trunnion and aft pins. This was a primary consideration for the design of an alternate mount.

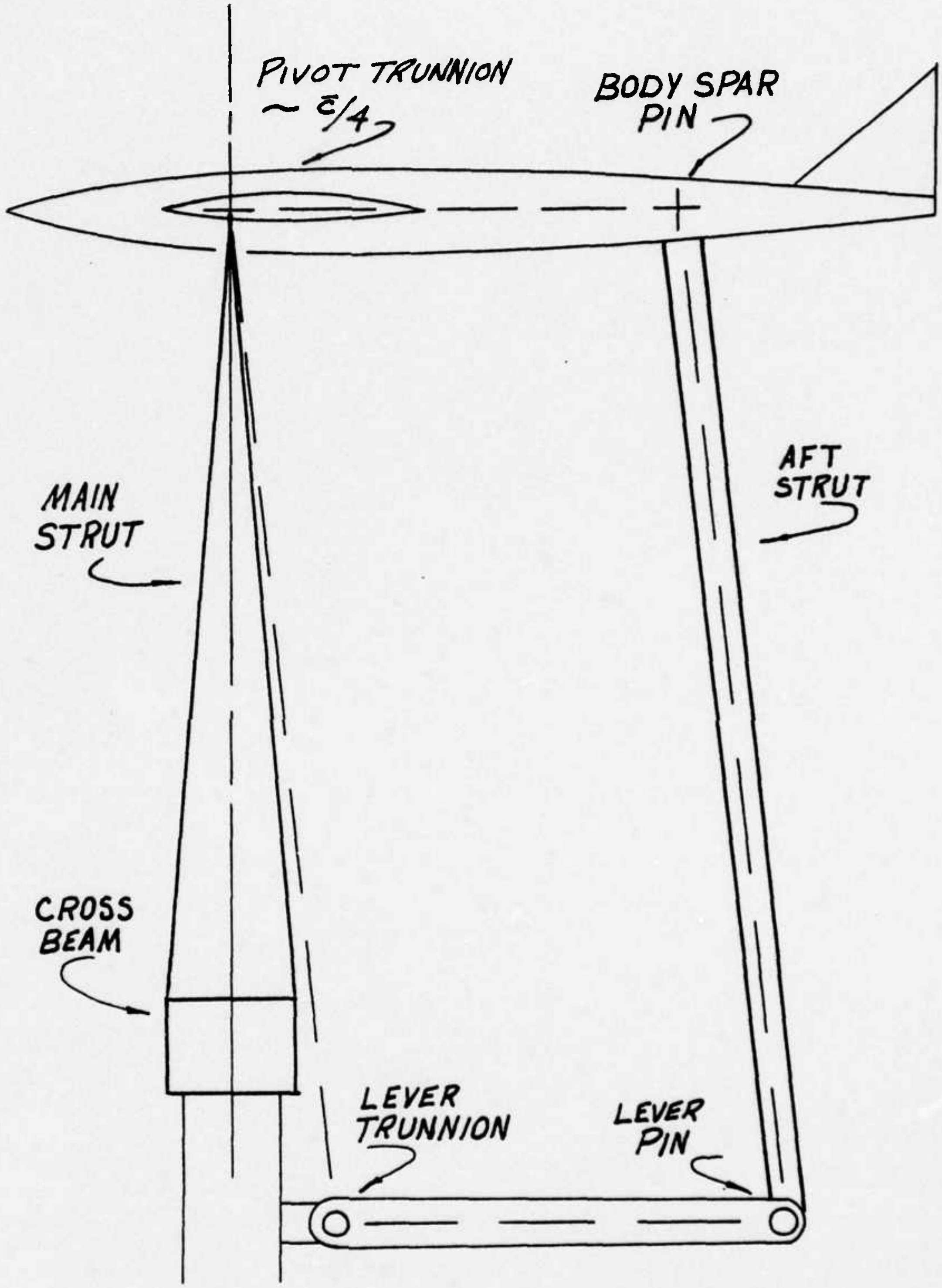



Figure 5. Balance parallelogram geometry.

## C. TEST SECTION LIMITATIONS ON MODEL SIZE

The primary NPS low-speed tunnel offers a 3.5 by 5.0 foot test section with 20-inch fillets forming an octagonal cross-section as seen in figure 6. The main limitations imposed by test section size are the model span and a trade-off between tail/canard moment arm and geometric angle of attack. The general rule of thumb for span is that it should be no more than 80% of the test section width. This yields a maximum span of four feet with six-inch tip clearance. Maximum moment arm is a function of maximum angle of attack and the allowable proximity of the tail or canard to a tunnel wall. A minimum six-inch clearance for the tail A.C. at maximum angle of attack was assumed for design purposes. The reason for the clearance requirement is the breakdown of potentially derived or empirically estimated wall corrections in the turbulent boundary layer.

A span of four feet and an aspect ratio of six yields a chord of 0.677 feet for a straight untapered wing. At standard sea level conditions and a Q of 60 psf, a Reynolds number of 950,000 resulted. Maximum tunnel Q, 100 psf, would only increase the Reynolds number to 1,250,000. These Reynolds number values are low for testing in the turbulent regime without some form of boundary layer tripping. Small aspect ratios and larger chords for the four-foot span would improve the situation, but low Reynolds numbers still represent a penalty inherent in small tunnels. For this reason tunnels

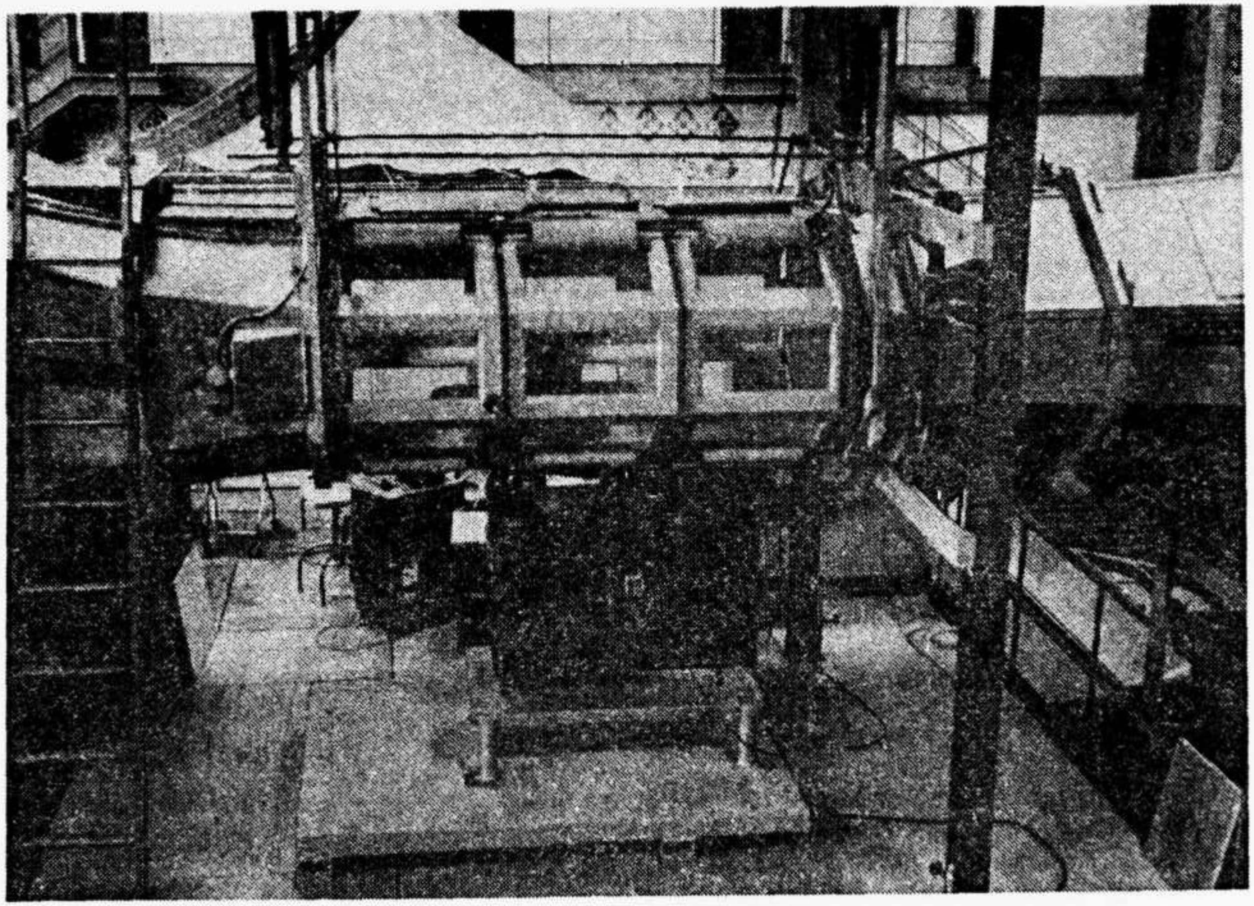


Figure 6. View of 3.5 x 5.0 test section.

of the 3.5 by 5.0 foot size represent those used primarily for academic purposes or for work where Reynolds number scaling is of lesser importance.

Test section size also affects the amount of deviation from the centerline that is negligible, and the allowable solid blockage by the mount. Of course, it is best to keep both to a minimum, but they are generally not driving concerns, providing tunnel flow calibrations are accurate and the velocity profile is well developed and uniform.

## D. ALTERNATE MOUNT PROPOSALS

Several mount configurations were proposed as solutions to the problem outlined in part A and the compatibility constraints listed in parts B and C. Balance limitation to three-component measurements considerably eased the problem of achieving sufficient lateral-directional rigidity. Minimum mount complexity and interference with the primary aerodynamic surfaces was sought. These goals indicated a reduction in the number of struts, removal of the attach points from the wing and a design that could be adapted to the measurement of aerodynamic tares. Candidate proposals then included the single strut, tandem struts, centerplate and tail sting mounts.

The single strut mount is the simplest and keeps interference to a minimum but is weak in torsion and concentrates the stresses at a single attach point under the fuselage of

a model. A fairly large strut width is required to provide sufficient rigidity and reasonable stress levels at design loads.

The tandem strut arrangement appeared to add no benefits at the cost of added complexity, but again, interference would be near minimum.

The centerplate mount represented what could be considered a continuous compromise of the previous two mount proposals. It would require only a single fairing, and the plate could fit in a slot along the under side of a model's fuselage. It seemed apparent that this mount would distribute the attachment forces more evenly, and that the detail of single point attachment would be eliminated. Width was traded for length, and the question of interference increase remained to be answered.

Tail sting mounting was the final consideration. Although it offered the least interference and nil blockage, the mount is optimized for single jet models in a high-speed tunnel. Limited angle of attack variation was another constraint of this type. A more complex adaptation for angle of attack drive would also be required.

Centerplate mounting appeared the most promising, and it was felt that the questioned increase in interference over the single strut mount would be negligible, if any. This approach was selected, and further design considerations are addressed in subsequent sections.

# III. MOUNT DESIGN

## A. CENTERPLATE CONFIGURATION TRADE-OFFS

After selection of the centerplate as the most promising design, several immediate engineering decisions were required to fix mount geometry. Since the mount would be expected to test a wide variety of models and wing types, a -15° to plus +30° angle of attack range was arbitrarily selected. The location of the plate trunnion about which the plate would describe a circular arc was a primary consideration. Selection of the arc radius with the plate at zero angle of attack fixes the trunnion location vertically below the test section centerline. Further considerations on this radius length were the tail-to-wall proximity at maximum angle of attack for a representative tail moment arm, 25 inches assumed, and the amount of fairing blockage required to shield the main support. Minimum radius length improves the former but is inverse for the latter. As stated previously, a minimum wall clearance of six inches for all aerodynamic surfaces was desired. A small radius also favors minimum deviation from test section centerline, but then incurs the possibility of interference by the proximity of the fairing. The trade-off considerations are depicted in figure 7.

Rough plots of various parameters as a function of arc radius were constructed and an engineering judgment on a 14-inch radius was made.

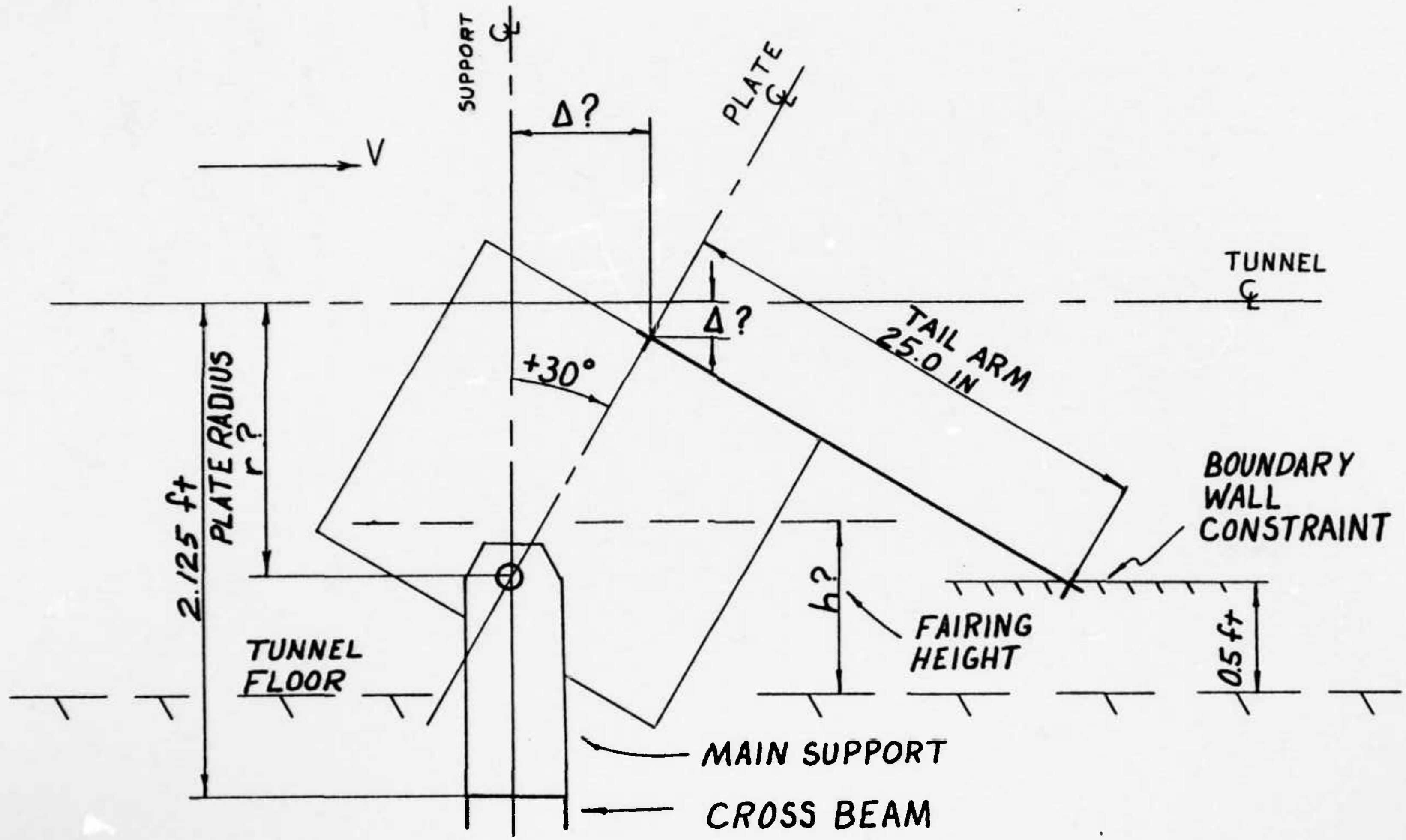



Figure 7. View of Sizing Tradeoffs.

The basic mount geometry was thus fixed. For an A.C. on the test section centerline and balance focal point when $\alpha = 0°$, its vertical deviation is -0.48 inches and the longitudinal deviation is $\pm$ 3.62 inches for $\alpha = \pm 15°$. The maximum vertical deviation is -1.88 inches and the maximum longitudinal deviations are +3.62 inches forward/-7.00 inches aft respectively for the design condition $\alpha = -15°, +30°$. Vertical deviation in the $\pm 15°$ case is 1.1% of tunnel height vs. 4.5% for the maximum +30° condition. It should be noted that the vertical displacement represents the only increase of tail/canard proximity compared to a three-strut mount pivoting about an axis through the centerline. These were considered acceptable for well developed, tunnel flow profiles. By mounting the wing above the plate's upper surface, maximum deviation of the A.C. can be reduced since the total variation could be made to center about the test section centerline in addition to the option of providing a desired design model angle condition on the test section centerline.

Plate length was selected as twenty inches, ten inches on each side of the vertical centerline when the plate is at $\alpha = 0°$. This represented a trade-off between model fuselage slot length, fairing length and lateral-directional rigidity. A fuselage spar was predicted to give added directional rigidity, and so a sizeable 20-inch width was selected to improve its torsional bending resistance for a given thickness.

## B. MOUNT CONSTRUCTION FEATURES

Having fixed centerplate geometry, the detailed design work remained. Simplicity, strength and rigidity were the primary design goals. A design safety factor of ten over yield for the most critical combination of maximum working loads outlined in section II, part B, indicates the emphasis on eliminating structural deformations.

A single stainless steel support with a vertical fork to accept the centerplate was adopted. A one-half inch diameter steel trunnion pin installed with an interference fit to the aluminum centerplate was supported in journal bearings of the flanking doublers. Plate thickness was selected as three-eighths inch, with twin three-sixteenth inch doublers below the level of the fairing.

The left fork of the main support was designed to be removable for initial installation of the centerplate assembly and for later adaptation or modification as desired. The plate was attached with four 1/4 - 20 cap screws and trued by two alignment pins.

The main support was directly attached to the Task balance by 1/4 - 20 cap screws and a backing plate. The bottom of the support was submerged five inches below the level of the tunnel floor. The remainder of the support and lower third of the centerplate incorporated a fairing for smooth flow and minimal interference.

The fairing consists of wooden, contoured leading and trailing edges, an angle frame of aluminum and two removable aluminum side plates. Close attention was paid to fairing aerodynamics to minimize cross flow separation at the leading edge and adverse pressure gradient separation at the trailing edge. A slot was milled into the upper cap to allow approximately one-sixteenth inch clearance for the centerplate. The entire fairing was to be mounted on a three-quarter inch plywood tunnel floor. The old flooring was retained to accommodate the original three-strut mount, if some unforeseen requirement for it should arise. The fairing was 12.5 inches high with a cross-section of 27.45 square inches. This represents a blockage factor of 1.31% for the tunnel test section. The resulting blockage appeared to be acceptable, and a tunnel Q calibration was performed with plate fairing installed.

The angle of attack was varied by a strut attached to the aft end of the centerplate and submerged under the fairing. An adjustable turnbuckle was incorporated to provide precise parallelogram alignment for proper angle of attack tracking.

The entire mount was fabricated to the specification of the author by the craftsmen of the Department of Aeronautics model shop from readily available materials. Critical part tolerance met or exceeded 0.002 inches.

## C. TUNNEL INTEGRATION

The original three-strut mount was removed after the collection of baseline data. The three-quarter inch plywood flooring was removed to keep the three-strut system intact. Then, the main support was checked on the main beam of the balance to insure correct fit. A new one-piece plywood floor was fabricated and mated to the test section framework. The fairing was then fastened along the test section centerline. The fairing sides were removed, and the centerplate was installed (see figure 8). The aft strut was adjusted, and the angle of attack was trued. The angle of attack was checked by a precision inclinometer throughout the design range of the mount, and found to be accurate within one second of arc. Concurrently, a check was made to ensure proper clearances of the plate, main support and aft strut. Rolling moments were applied to the plate to ensure minimal torsional deflection and to confirm that plate and fairing slot interference would not occur. An interference light was rigged with a series circuit between the balance and fairing. Subsequent runs indicated no fairing interference and that torsional rigidity was not a factor at the highest Q tested for a representative wing, 50 psf. Some minor alterations to the fairing framework were made to improve access to the main support side plate, but no major problems were encountered in the installation phase.

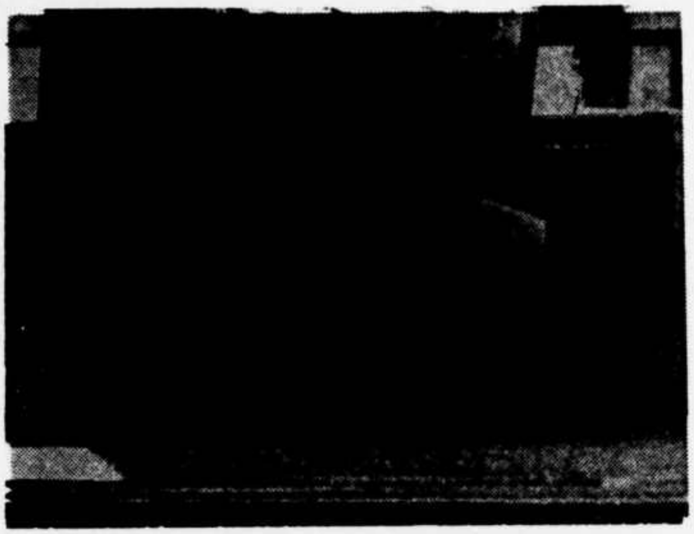


Figure 8. View of centerplate installation

Figure 9. Q calibration testing.

Once installed, a dynamic pressure calibration was performed to account for the revised tunnel configuration, including the centerplate fairing (see figure 9). The procedure was to take readings of a shrouded total pressure, a piezo ring static pressure, and a pitot-static tube which included total Q and static pressure measured over the fairing on the tunnel centerline. The first two pressure sources combine to yield a reference Q, $Q_{ref}$, while the last two pressures establish the Q to be calibrated, $Q_{cal}$.

Initially, an attempt to measure these values was made with a scanivalve; however, tunnel turbulence and the time delay of manual switching between data channels produced widely scattered data. At this point the power of the data acquisition system was utilized, and it was reprogrammed to scan each pressure transducer 128 times during a two-second time frame and numerically average the sample readings. The resulting scatter was noticeably reduced. Further refinement of the Q readings was made by incorporation of the subsonic pitot-static correction for compressibility effects [Ref. 5]. For Q's available to the low-speed tunnel, errors on the order of 1.0% could occur if the Mach correction were not taken into account. A summary of this Q correction is presented in figure 10.

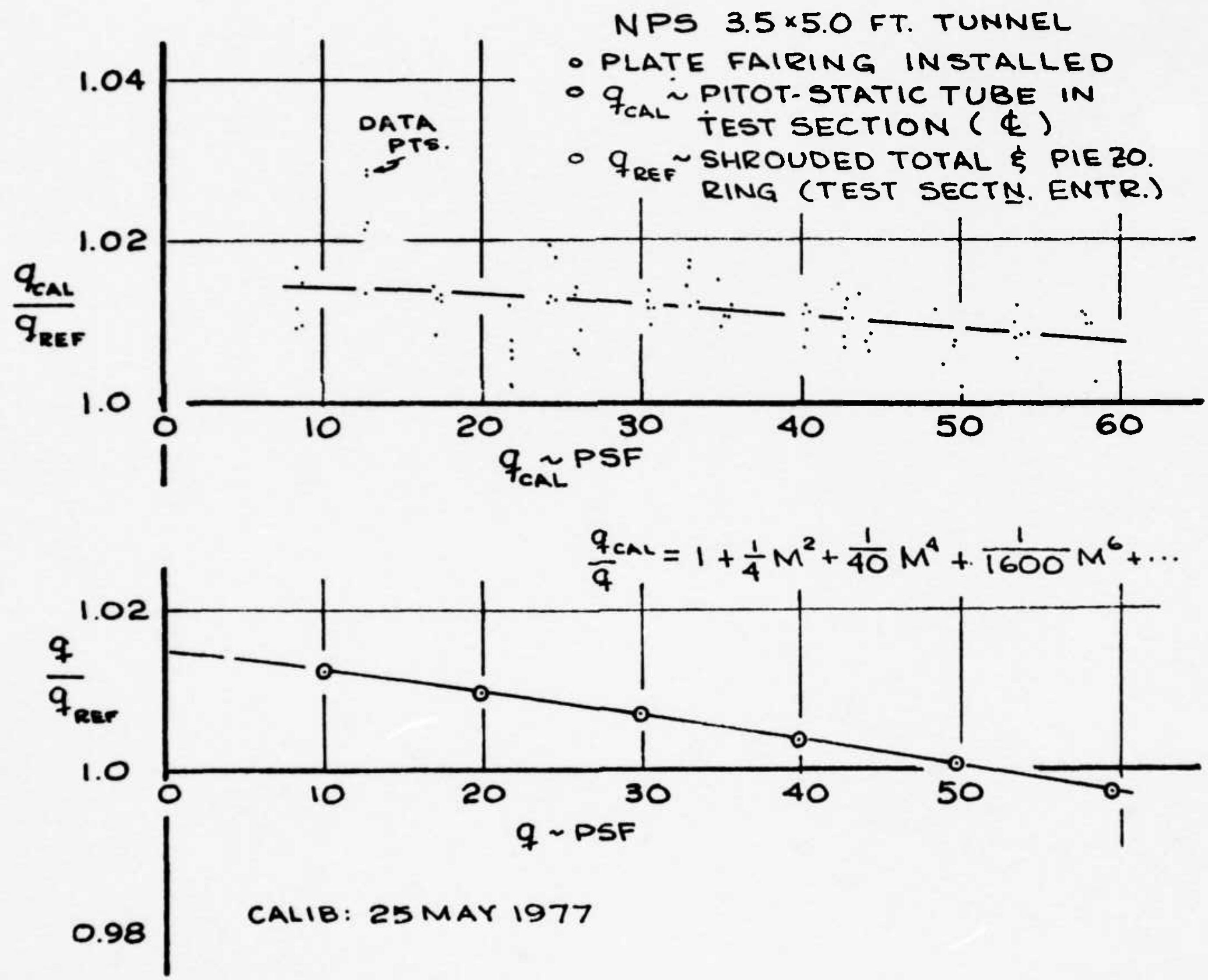



Figure 10. Q calibration curves.

# IV. PROOF OF CONCEPT EXPERIMENT

During the time period when the plate mount system was being fabricated, experiments were initiated to provide baseline data suitable for verification of the plate mount concept using an existing calibration wing. An added goal of the test sequence was the proof testing under actual laboratory conditions of the microprocessor oriented data acquisition system developed independently by Casko (Ref. 2). Initial testing, after modification of the Task MK I balance, indicated that inaccuracies were present due to the unavailability of the aerodynamic tares and the interference inherent when testing with a three-strut model support system. The accurately constructed calibration wing, which was available for the three-strut mount tests (see Figure 1), was subsequently adapted for comparable experiments upon the plate mounting system.

## A. PRELIMINARY PREPARATION

The signal conditioning amplifiers used by Concannon (Ref. 1) when acquiring his reported strain gage calibrations were rebuilt by the Department of Aeronautics for the express purpose of making possible improved electronic interfacing with the new data acquisition system. Therefore, a more current set of calibration matrix constants had to be determined. This was performed with a static loading frame and

calibration weights on the three-strut mounting system while installed in the tunnel test section. Following procedures outlined by Concannon in Ref. 1, the balance was calibrated to resolve lift force, drag force and pitching moment relative to a lateral axis through the intersection of the main strut trunnion axis and the vertical centerline of the balance cross beam. It is important to note that the accurate resolution of forces and moments about this axis (the virtual center or focal point of the balance) is independent of the type of support mount used, and any offset of a desired model reference point requires a moment transfer. Numerical values for the correlated reduction matrix constants may be found in Appendix A.

It should also be noted that the first stage fan blades were removed from the tunnel for refurbishing prior to the course of these experiments, which in turn effectively limited the tunnel test section operating dynamic pressure (Q) to approximately 55 pounds per square foot (psf). No advantage was seen in pushing the single stage fan to its limit, hence a dynamic pressure range of 20 to 40 psf was selected for test purposes.

## B. DESCRIPTION OF CALIBRATION WING

The calibration wing available for the experiment had a modified NACA 63-010 airfoil, constant over a three-foot span. The wing was without taper or twist, and had a six-inch chord. The rectangular wing tip sections were adapted

from NACA 63-015 contours. The wing attached to the main struts of the three-point mount at two wing trunnions located six inches on either side of the longitudinal axis, and coincident with the quarter-chord line. A thin steel sting attached to the wing spar and trailed aft to the tail strut pin attachment point. Sting width in the airfoil section was 0.50 inches, and it was filleted to 0.25 inches from the wing trailing edge to the aft tail strut clevis pin region. The sting moment arm for the three-strut mount was 15.00 inches.

## C. THREE-STRUT MOUNTING SYSTEM EXPERIMENTS

The objective of the three-strut mount experiments was to document accurately the performance of the calibration wing upon this type of support system without aerodynamic tare estimations being applied. The main struts were carefully faired by individual windshields to within approximately four inches of the wing surface. The aft (tail) strut was unfaired.

Wind-off weight tares for the aforementioned configuration were recorded through the angle of attack test range of -6.0 to +14.0 degrees by one degree increments. The tunnel Q was set to approximately 40 psf, and uncorrected aerodynamic data were recorded as printout on an ASR-33 Teletype unit. It should be noted that each printed row of information included five channels of data at a particular angle of

attack condition, including a numerically averaged Q value obtained during that two-second sampling period. This feature of the data acquisition system eliminated the necessity for precise tunnel dynamic pressure management.

After several days had transpired, the above data collection procedure was duplicated in its entirety to verify the repeatability of the system. Additional data for test runs at Q values of 20 and 30 psf were also collected. Each pitch-pause polar run required about eight minutes for approximately 30 individual angle of attack settings.

## D. ADAPTATION OF CALIBRATION WING

The calibration wing was originally designed for a three-strut support system. The wing attachment points had approximately two-inch square, contoured cover plates on both upper and lower surfaces (see figure 2). These were faired in with modeling clay and smoothed. The wing also had a one-half inch channel to accept the tail sting.

The forward section of the tail sting was duplicated to adapt the wing, but sufficient steel material was retained on the underside of the adaptor to allow the milling of a plate attachment slot. The centerplate was secured in this slot by two 1/4-20 cap screws. Two additional cap screws were inserted vertically through the adaptor and wing spar to fasten into tapped holes on the plate's upper surface. The wing adaptor was designed to position the wing quarter-chord

on the plate's vertical centerline, which aligned with the balance focal point at zero angle of attack. This feature was provided for geometrical simplifications in the moment transfer equations, as outlined in Appendix B.

A slender, bullet-shaped body fairing was incorporated to insure minimal flow disruption at the wing root. The fairing was constructed with two separate wooden center sections. One center section was solid (without wing cutouts) to provide a smooth fairing during wing-off weight and aerodynamic tare evaluations (see Figure 11). The other center section was contoured to accept the wing adaptor and wing panel (see Figure 12). Both fairings were fastened to either plate or wing adaptor by cap screws. Careful attention to tolerance details provided a close fit of the fairing to wing and plate and enhanced the torsional rigidity of the wing root, inasmuch as the actual wing spar details allowed only a one-half inch wide steel adaptor.

The fairing was kept as small as possible, and the two-inch fairing diameter represented 5.56 percent of the wing's three foot span. The small relative size of the body fairing provided an intuitive feeling that wing lift carry-over in the fairing area would be quite reasonable.

An approximate stress analysis was performed for wing root bending of the aluminum wing spar. A 40 percent margin over yield was estimated for design loads at Q = 60 psf. This seemed reasonable, since maximum test Q was selected as 40 psf.

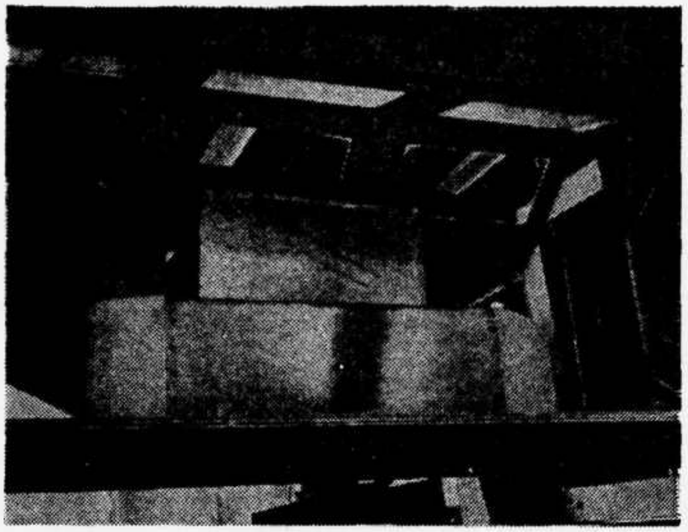


Figure 11. Centerplate and bullet fairing, wing-off.

Figure 12. Centerplate and bullet fairing, wing-on.

## E. CENTERPLATE MOUNTING SYSTEM EXPERIMENTS

The objective of the centerplate mount experiments was to document accurately the performance of the modified calibration wing when installed on the plate mount, including estimates of the aerodynamic tares for the wing-off configuration. With this information, a quantitative comparison between both support systems could be made with reasonable certainty.

After the centerplate (described in Section III C) was installed, the body fairing was fastened onto the upper edge of the plate and wind-off weight tares were taken (see Section IV C). Wind-on runs were then conducted for Q values of 40, 30 and 20 psf, respectively.

The body fairing was removed from the tunnel, the wing-on center section was fitted, and then the entire wing-body assembly was reinstalled onto the plate support in the tunnel test section. A complete repetition of the previous wing-off steps was then performed.

Incorporation of tares for both wing-off/on cases was accomplished by means of computer programs presented in a following section.

## F. THEORETICALLY EXPECTED RESULTS

Independent of mounting considerations, one should have an engineering feel for the expected results of a finite wing with a symmetrical airfoil. Section data on NACA 63-010 and

NACA 63-009 airfoils (Ref. 6) were the basis for approximate estimates of the ideal, free-air behavior of the calibration wing. The lift curve, drag polar and pitching moment curve will be reviewed in that order.

The referenced section data indicated a linear section lift curve slope of approximately 0.10 $deg^{-1}$. Correction for a wing aspect ratio of six yielded a three-dimensional lift curve slope on the order of 0.073 $deg^{-1}$ (Ref. 7). Of course, a finite wing's $C_{L_{max}}$ will occur at an angle of attack several degrees higher than the 10 degree value observed in the sectional data. However, approximately the same maximum lift coefficient would be expected for both two- and three-dimensional wing cases when operated with approximately the same Reynolds number values. Further inspection of symmetrical airfoil behavior indicates a lift curve symmetric about the origin with a zero lift angle ($\alpha_{oL}$) of zero.

The drag polar (plot of $C_L$ vs. $C_D$) is also symmetric, but about the coefficient of drag axis with a zero lift drag ($C_{D_o}$) value of approximately 0.008 (80 drag counts). The $C_{D_o}$ values of both the two- and three-dimensional wing cases should be identical, since induced drag is not a factor at zero lift for an untwisted and uncambered wing. Note that the $C_{D_o}$ estimate of 0.008 was based for a model with standard roughness, and no drag-bucket phenomenon (characteristic of laminar flow airfoils) was expected.

As a check on the magnitude of the drag tares for the centerplate and fairing, an estimate of the turbulent skin friction drag at Q = 40 psf in sea-level conditions was performed.

Plate Reynolds number:

$$(R_N)_{Plate} = \frac{Vx}{\nu} = \frac{(183.5 \text{ ft/sec})(1.67 \text{ ft})}{0.000158 \text{ ft}^2/\text{sec}} \cong 1.94 \times 10^6$$

Body fairing Reynolds number:

$$(R_N)_{Fairing} \cong 1.94 \times 10^6 * \frac{(2.67 \text{ ft})}{(1.67 \text{ ft})} \cong 3.10 \times 10^6$$

If the entire plate were in turbulent flow, then skin-friction drag would be:

$$D_{f_p} = 2 \times Q \times S \times C_f$$

where

$$C_f = 0.455 \times (\log_{10} R_N)^{-2.58}$$

Hence $D_{f_p} = 2 \times (40 \text{ psf})(1.18 \text{ ft}^2)(0.00396) = 0.374$ lb

If the entire body fairing were in turbulent flow, then:

$$D_{f_F} = 1 \times (40 \text{ psf})(1.40 \text{ ft}^2)(0.00379) = 0.212 \text{ lb}$$

where $S_f$ = cylindrical approximation to body fairing wetted area. Total drag then becomes:

$$D_T = D_{f_p} + D_{f_F} = 0.586 \text{ lb}$$

And the drag coefficient, referenced to wing area, would be:

$$C_{D_T} = \frac{D_T}{QS} = \frac{0.586 \text{ lb}}{(40 \text{ psf})(1.5 \text{ ft}^2)} = 0.0098$$

The turbulent flow approximation was assumed based upon the observation that the leading edge of the centerplate had a 0.030-inch bluntness for safety and ease of fabrication, while the plate surface was smooth but unpolished for the experiment.

Wing-alone stability as measured by the slope $dC_{M_{\bar{c}/4}}/dC_L$ provides a direct indication of the wing aerodynamic center location. The slope would be zero if the aerodynamic center were located at the wing quarter-MAC location. Additionally, the symmetry of the airfoil would lead one to expect a zero value of $C_{M_{\bar{c}/4}}$ at zero left; i.e., $C_{M_o} = 0$.

## V. PRESENTATION OF DATA

A summary of all the wind tunnel runs performed in conjunction with this study are listed in Table 1. Corrected aerodynamic data for the runs at Q = 40, 30, and 20 psf are presented in that order. Each tabulated run in this section represents reduced data for 27 geometric angle of attack conditions. The geometric angle of attack was varied from minus six degrees to plus fourteen degrees in one degree increments. As a repeatability check within each run, the angle of attack was then returned to plus six degrees and reduced in two degree increments to minus four degrees. The data presented for each geometric angle of attack condition were the aerodynamic angle of attack, Q, $C_L$, $C_D$, and $C_{M\bar{c}/4}$. The three-strut configuration data are corrected only for weight tares. Centerplate configuration data are corrected for aerodynamic tares as well as weight tares, and tables of the reduced aerodynamic tare coefficients are presented immediately behind their respective run data.

Three-strut run 051501 and centerplate run 052703 at Q = 40 psf were selected as the most representative because of the higher nominal Q and subsequent removal of any possible taxing of balance resolution. Plots of $C_L$ vs. $\alpha$, $C_D$ and $C_{M\bar{c}/4}$ were constructed for these data and immediately precede the table for their respective runs. The plots of run 051501

were reproduced on the plots for run 052703 to facilitate a direct comparison of calibration wing performance on each mounting system.

The reduction programs and storage records are presented in later sections of this report. The raw data are displayed in Appendix C.

Reference is not included on Reynolds number since the runs were made in virtually identical conditions and no scaling correlations were attempted.

Table I

Wind-Tunnel Run Log

| DATE | RUN # | NOMINAL Q (psf) | PURPOSE |
|---|---|---|---|
| 5-15-77 | 051577 | 0 | Weight tare, calibration wing on three-strut mount |
| " | 051501 | 40 | Data for $C_L$ vs., $C_D$, $C_{M\bar{c}/4}$ |
| 5-18-77 | 051877 | 0 | Weight tare, calibration wing on three-strut mount |
| " | 051801 | 40 | Data for $C_L$ vs., $C_D$, $C_{M\bar{c}/4}$ |
| " | 051802 | 30 | " " |
| " | 051803 | 20 | " " |
| 5-24-77 | --- | 8-58 | Q calibration, plate fairing in clear tunnel |
| 5-26-77 | 052677 | 0 | Weight tare, plate plus fairing, wing-off |
| " | 052601 | 20 | Aerodynamic tares for $C_L$, $C_D$, $C_{M\bar{c}/4}$ |
| " | 052602 | 40 | " " |
| " | 052603 | 30 | " " |
| 5-27-77 | 05277 | 0 | Weight tare, plate plus fairing, wing-on |
| " | 052701 | 20 | Data for $C_L$ vs., $C_D$, $C_{M\bar{c}/4}$ |
| " | 052702 | 30 | " " |
| " | 052703 | 40 | " " |

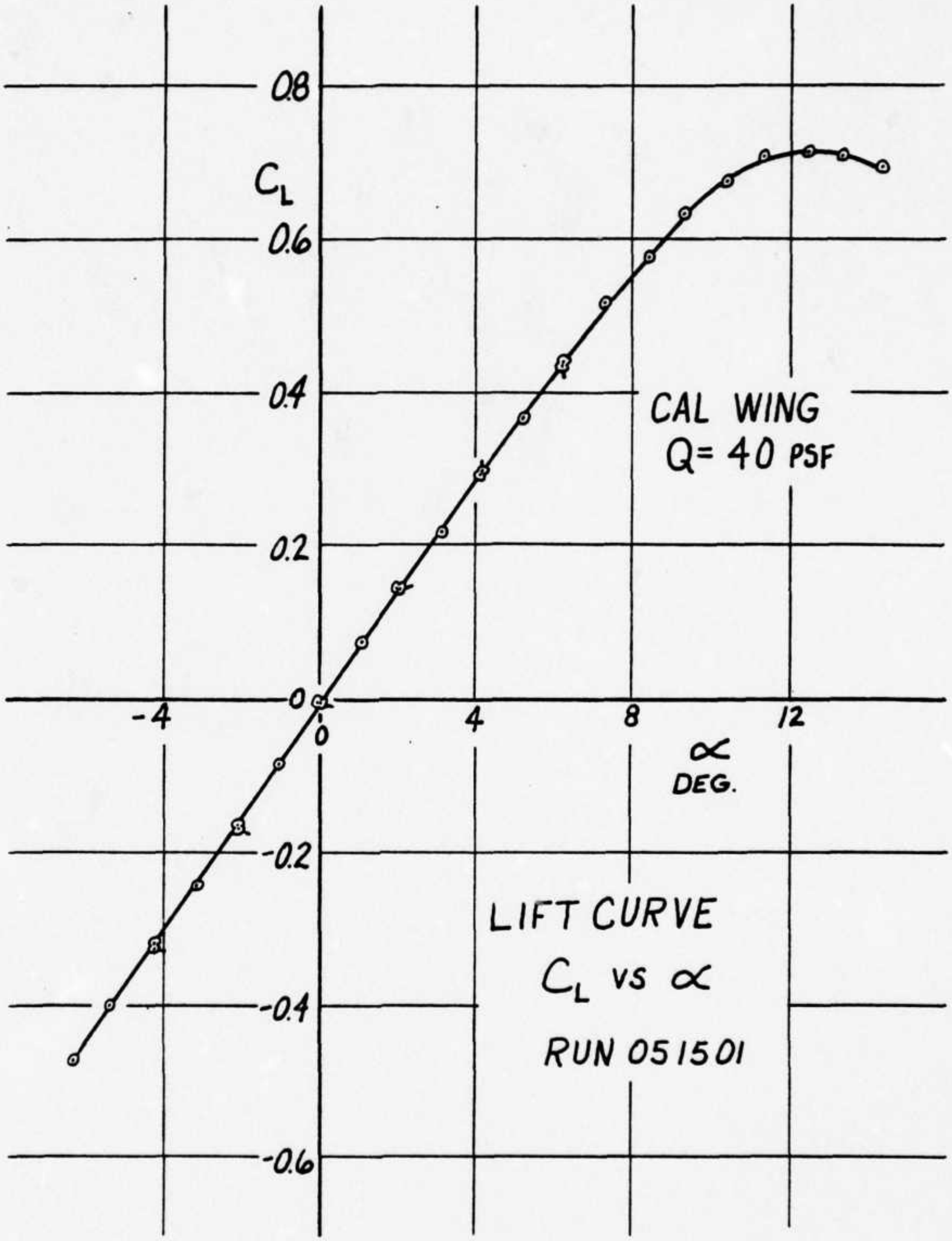



Figure 13. Lift curve, three-strut mount.

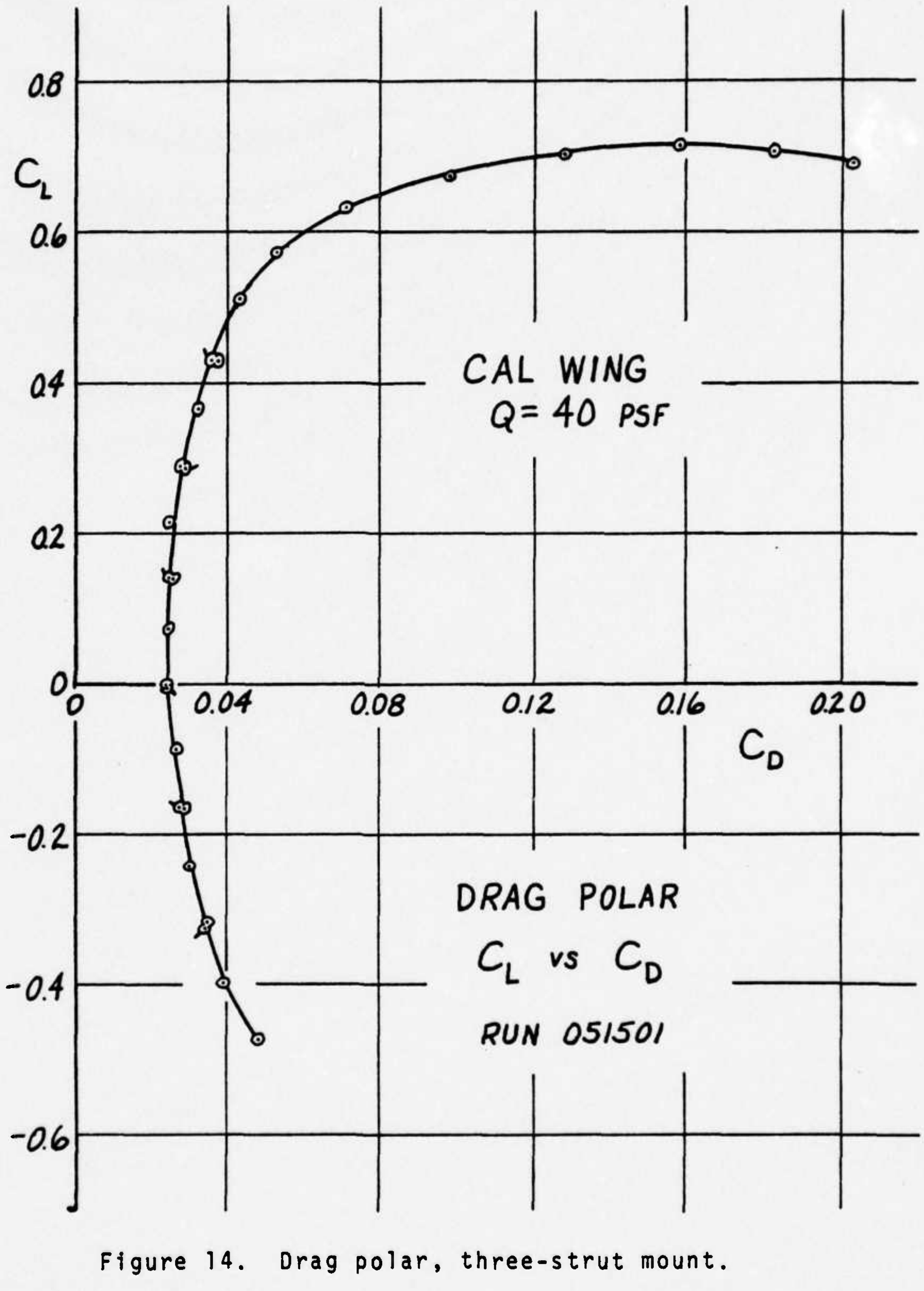



Figure 14. Drag polar, three-strut mount.

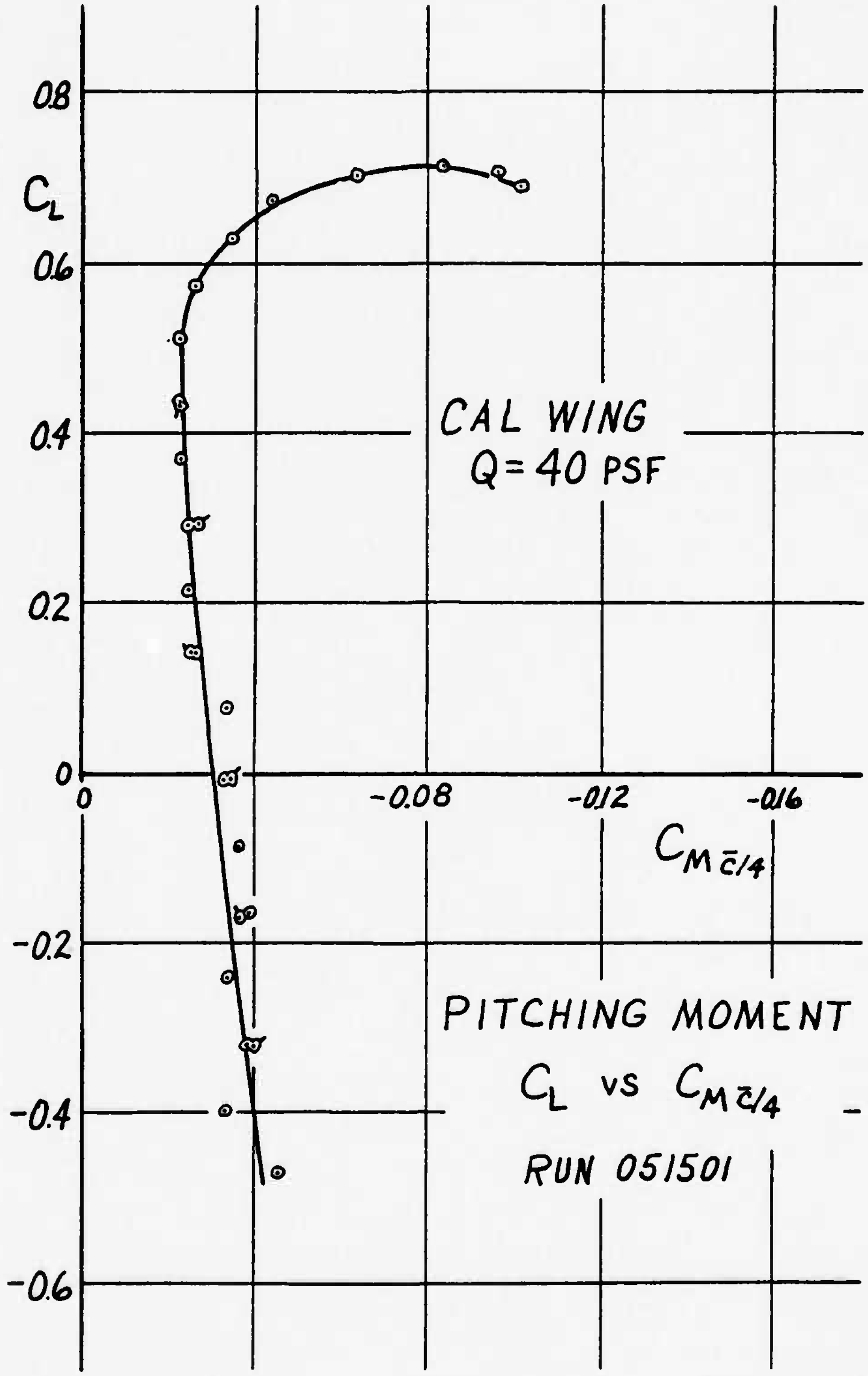



Figure 15. Pitching moment curve, three-strut mount.

## TABLE II

CORRECTED DATA OF RUN # 51501

| ROW # | AOA(DEG) | Q(PSF) | CL | CD | CM-C/4 |
|---|---|---|---|---|---|
| 1 | -0.8917 | 41.2018 | -0.4769 | 0.0468 | -0.0395 |
| 2 | -0.7407 | 41.4827 | -0.3968 | 0.0389 | -0.0336 |
| 3 | -0.5911 | 41.2767 | -0.3166 | 0.0348 | -0.0374 |
| 4 | -0.4446 | 40.8366 | -0.2406 | 0.0299 | -0.0328 |
| 5 | -0.2967 | 41.8011 | -0.1640 | 0.0281 | -0.0375 |
| 6 | -0.1485 | 42.2318 | -0.0836 | 0.0263 | -0.0352 |
| 7 | -0.0031 | 41.8853 | -0.0071 | 0.0248 | -0.0320 |
| 8 | 0.1474 | 41.4827 | 0.0750 | 0.0250 | -0.0324 |
| 9 | 0.2836 | 41.9228 | 0.1420 | 0.0247 | -0.0265 |
| 10 | 0.4326 | 42.2599 | 0.2190 | 0.0262 | -0.0254 |
| 11 | 0.5792 | 42.6157 | 0.2927 | 0.0288 | -0.0236 |
| 12 | 0.7228 | 42.9434 | 0.3662 | 0.0322 | -0.0223 |
| 13 | 0.8676 | 42.4471 | 0.4365 | 0.0372 | -0.0215 |
| 14 | 1.0161 | 42.8030 | 0.5133 | 0.0427 | -0.0214 |
| 15 | 1.1540 | 42.7280 | 0.5774 | 0.0532 | -0.0249 |
| 16 | 1.2849 | 42.0913 | 0.6332 | 0.0714 | -0.0342 |
| 17 | 1.4132 | 41.8011 | 0.6773 | 0.0970 | -0.0428 |
| 18 | 1.5335 | 41.0520 | 0.7038 | 0.1275 | -0.0631 |
| 19 | 1.6438 | 40.9490 | 0.7158 | 0.1576 | -0.0835 |
| 20 | 1.7326 | 41.2299 | 0.7073 | 0.1816 | -0.0973 |
| 21 | 1.8235 | 40.2093 | 0.6940 | 0.2032 | -0.1119 |
| 22 | 0.8661 | 42.0258 | 0.4339 | 0.0367 | -0.0212 |
| 23 | 0.5771 | 41.1456 | 0.2874 | 0.0293 | -0.0268 |
| 24 | 0.2875 | 41.2486 | 0.1429 | 0.0243 | -0.0258 |
| 25 | -0.0029 | 40.7898 | -0.0086 | 0.0249 | -0.0335 |
| 26 | -0.3003 | 39.3291 | -0.1670 | 0.0273 | -0.0350 |
| 27 | -0.5917 | 39.9003 | -0.3230 | 0.0344 | -0.0390 |

## TABLE III

CORRECTED DATA OF RUN # 51801

| ROW # | AOA(DEG) | Q(PSF) | CL | CD | CM-C/4 |
|---|---|---|---|---|---|
| 1 | -0.8874 | 41.0404 | -0.4754 | 0.0453 | -0.0328 |
| 2 | -0.7446 | 40.0947 | -0.4031 | 0.0392 | -0.0324 |
| 3 | -0.5949 | 40.9936 | -0.3228 | 0.0331 | -0.0297 |
| 4 | -0.4466 | 39.6453 | -0.2418 | 0.0288 | -0.0270 |
| 5 | -0.2976 | 39.6172 | -0.1654 | 0.0271 | -0.0312 |
| 6 | -0.1532 | 41.1341 | -0.0914 | 0.0247 | -0.0272 |
| 7 | -0.0034 | 41.1060 | -0.0076 | 0.0244 | -0.0290 |
| 8 | 0.1420 | 40.9936 | 0.0664 | 0.0245 | -0.0281 |
| 9 | 0.2879 | 41.9299 | 0.1438 | 0.0249 | -0.0262 |
| 10 | 0.4352 | 41.5273 | 0.2215 | 0.0259 | -0.0218 |
| 11 | 0.5798 | 41.8738 | 0.2935 | 0.0288 | -0.0232 |
| 12 | 0.7212 | 41.6678 | 0.3635 | 0.0330 | -0.0251 |
| 13 | 0.8696 | 41.7801 | 0.4394 | 0.0374 | -0.0232 |
| 14 | 1.0127 | 41.6210 | 0.5119 | 0.0429 | -0.0209 |
| 15 | 1.1516 | 42.0236 | 0.5750 | 0.0531 | -0.0222 |
| 16 | 1.2873 | 41.5929 | 0.6334 | 0.0725 | -0.0356 |
| 17 | 1.4129 | 41.7240 | 0.6767 | 0.0983 | -0.0449 |
| 18 | 1.5317 | 41.4711 | 0.7042 | 0.1612 | -0.2365 |
| 19 | 1.6410 | 41.6490 | 0.7210 | 0.1569 | -0.0838 |
| 20 | 1.7367 | 40.6752 | 0.7157 | 0.1817 | -0.0975 |
| 21 | 1.8167 | 40.5442 | 0.6829 | 0.2011 | -0.1102 |
| 22 | 0.8644 | 41.3213 | 0.4360 | 0.0374 | -0.0224 |
| 23 | 0.5786 | 42.0142 | 0.2916 | 0.0290 | -0.0235 |
| 24 | 0.2849 | 41.2183 | 0.1388 | 0.0250 | -0.0259 |
| 25 | -0.0002 | 40.9842 | -0.0023 | 0.0245 | -0.0282 |
| 26 | -0.2983 | 39.7576 | -0.1665 | 0.0270 | -0.0318 |
| 27 | -0.5982 | 40.6565 | -0.3282 | 0.0344 | -0.0350 |

TABLE IV

CORRECTED DATA OF RUN # 51802

| ROW # | AOA(DEG) | Q(PSF) | CL | CD | CM-C/4 |
|---|---|---|---|---|---|
| 1 | -0.8828 | 30.2724 | -0.4721 | 0.0445 | -0.0335 |
| 2 | -0.7404 | 29.9447 | -0.4000 | 0.0374 | -0.0276 |
| 3 | -0.5964 | 29.7294 | -0.3255 | 0.0324 | -0.0296 |
| 4 | -0.4449 | 30.2350 | -0.2388 | 0.0275 | -0.0246 |
| 5 | -0.2933 | 29.6732 | -0.1582 | 0.0256 | -0.0282 |
| 6 | -0.1503 | 30.0103 | -0.0864 | 0.0230 | -0.0225 |
| 7 | -0.0048 | 30.3848 | -0.0098 | 0.0221 | -0.0214 |
| 8 | 0.1440 | 29.7106 | 0.0696 | 0.0224 | -0.0222 |
| 9 | 0.2906 | 30.7032 | 0.1481 | 0.0234 | -0.0227 |
| 10 | 0.4333 | 30.6751 | 0.2199 | 0.0249 | -0.0197 |
| 11 | 0.5767 | 30.7125 | 0.2887 | 0.0275 | -0.0179 |
| 12 | 0.7291 | 30.7500 | 0.3742 | 0.0317 | -0.0191 |
| 13 | 0.8676 | 31.0028 | 0.4411 | 0.0358 | -0.0178 |
| 14 | 1.0154 | 30.7032 | 0.5161 | 0.0433 | -0.0221 |
| 15 | 1.1509 | 30.4035 | 0.5761 | 0.0541 | -0.0226 |
| 16 | 1.2892 | 30.8998 | 0.6316 | 0.0712 | -0.0204 |
| 17 | 1.4138 | 30.7593 | 0.6732 | 0.0994 | -0.0453 |
| 18 | 1.5309 | 30.2537 | 0.7078 | 0.1743 | -0.3004 |
| 19 | 1.6379 | 30.0758 | 0.7160 | 0.1578 | -0.0858 |
| 20 | 1.7313 | 30.2537 | 0.7101 | 0.1818 | -0.0980 |
| 21 | 1.8228 | 30.4316 | 0.6929 | 0.2042 | -0.1151 |
| 22 | 0.8648 | 30.9372 | 0.4368 | 0.0370 | -0.0240 |
| 23 | 0.5796 | 30.5533 | 0.2932 | 0.0284 | -0.0231 |
| 24 | 0.2834 | 31.0028 | 0.1364 | 0.0247 | -0.0289 |
| 25 | -0.0047 | 30.8998 | -0.0096 | 0.0236 | -0.0284 |
| 26 | -0.2946 | 30.7593 | -0.1606 | 0.0264 | -0.0334 |
| 27 | -0.5978 | 30.4410 | -0.3276 | 0.0326 | -0.0288 |

## TABLE V

CORRECTED DATA OF RUN # 51803

| ROW # | AOA(DEG) | Q(PSF) | CL | CD | CM-C/4 |
|---|---|---|---|---|---|
| 1 | -0.9016 | 20.1786 | -0.4986 | 0.0424 | -0.0343 |
| 2 | -0.7527 | 20.4595 | -0.4203 | 0.0361 | -0.0307 |
| 3 | -0.6109 | 20.7966 | -0.3491 | 0.0317 | -0.0317 |
| 4 | -0.4609 | 20.3752 | -0.2651 | 0.0251 | -0.0187 |
| 5 | -0.3103 | 20.2442 | -0.1863 | 0.0243 | -0.0293 |
| 6 | -0.1575 | 20.6374 | -0.0983 | 0.0217 | -0.0221 |
| 7 | -0.0115 | 20.7123 | -0.0209 | 0.0227 | -0.0290 |
| 8 | 0.1308 | 20.7966 | 0.0529 | 0.0219 | -0.0239 |
| 9 | 0.2847 | 20.8809 | 0.1392 | 0.0225 | -0.0217 |
| 10 | 0.4299 | 20.6749 | 0.2144 | 0.0235 | -0.0146 |
| 11 | 0.5719 | 20.8060 | 0.2830 | 0.0260 | -0.0117 |
| 12 | 0.7269 | 21.0307 | 0.3728 | 0.0308 | -0.0172 |
| 13 | 0.8723 | 20.6749 | 0.4440 | 0.0340 | -0.0080 |
| 14 | 1.0158 | 21.1056 | 0.5170 | 0.0414 | -0.0107 |
| 15 | 1.1590 | 20.6468 | 0.5853 | 0.0536 | -0.0117 |
| 16 | 1.2797 | 20.9277 | 0.6215 | 0.0678 | -0.0076 |
| 17 | 1.4087 | 21.0213 | 0.6697 | 0.0971 | -0.0205 |
| 18 | 1.5226 | 20.3846 | 0.6926 | 0.1946 | -0.3953 |
| 19 | 1.6317 | 20.5251 | 0.7058 | 0.1567 | -0.0830 |
| 20 | 1.7286 | 20.5157 | 0.7008 | 0.1828 | -0.1032 |
| 21 | 1.8135 | 20.5906 | 0.6777 | 0.2031 | -0.1187 |
| 22 | 0.8724 | 20.8809 | 0.4439 | 0.0355 | -0.0180 |
| 23 | 0.5815 | 20.6936 | 0.2966 | 0.0260 | -0.0148 |
| 24 | 0.2778 | 20.7779 | 0.1273 | 0.0226 | -0.0202 |
| 25 | -0.0131 | 20.5906 | -0.0235 | 0.0219 | -0.0246 |
| 26 | -0.3105 | 20.7779 | -0.1868 | 0.0250 | -0.0319 |
| 27 | -0.6123 | 20.3565 | -0.3516 | 0.0313 | -0.0265 |

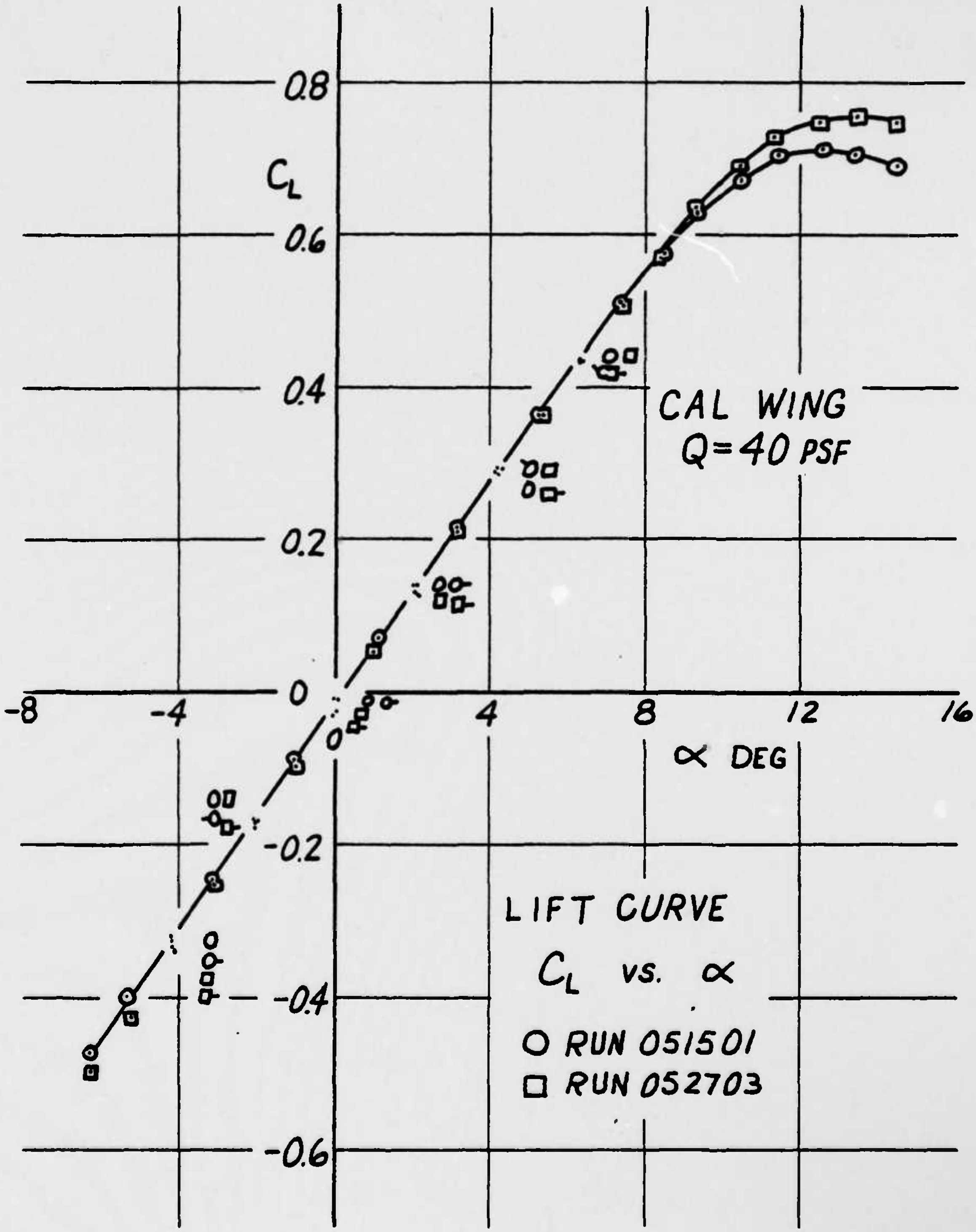



Figure 16. Lift curve, centerplate mount.

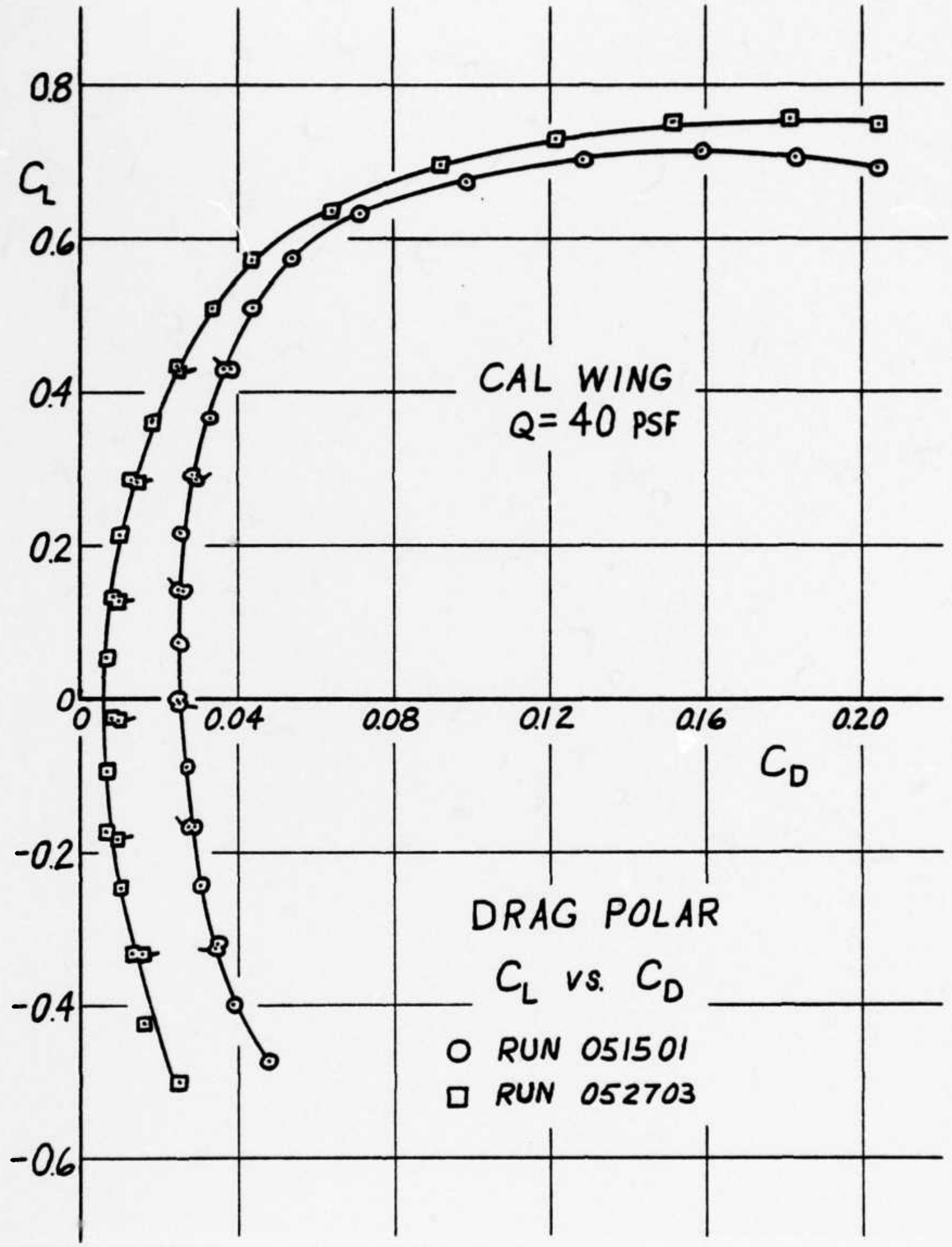



Figure 17. Drag polar, centerplate mount.

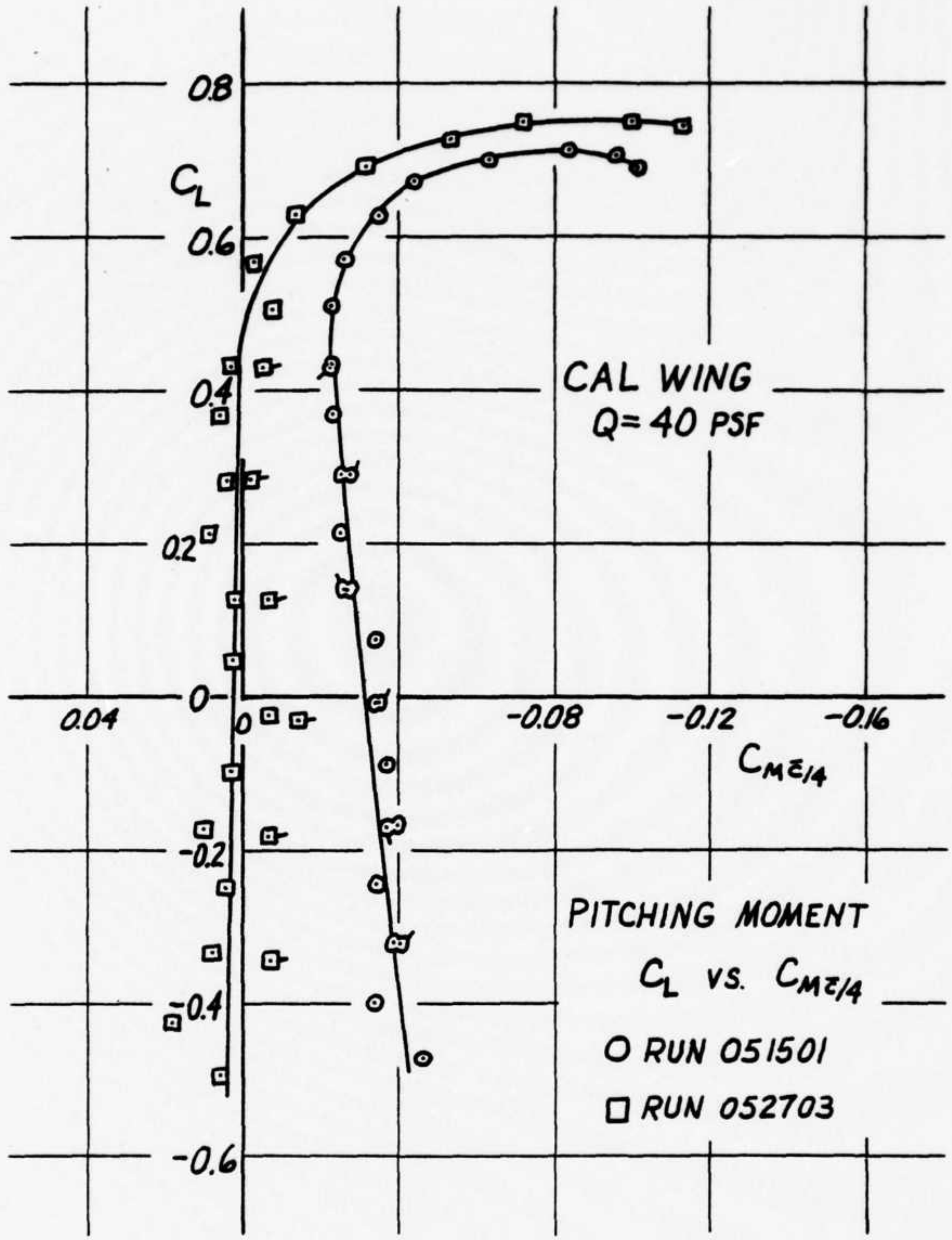



Figure 18. Pitching moment curve, centerplate mount.

## TABLE VI

CORRECTED DATA OF RUN # 52703

| ROW # | AOA(DEG) | Q(PSF) | CL | CD | CM-C/4 |
|---|---|---|---|---|---|
| 1 | -6.2505 | 39.4395 | -0.4958 | 0.0248 | 0.0074 |
| 2 | -5.2190 | 39.7807 | -0.4212 | 0.0169 | 0.0191 |
| 3 | -4.1657 | 39.4495 | -0.3338 | 0.0130 | 0.0084 |
| 4 | -3.1060 | 40.1219 | -0.2458 | 0.0099 | 0.0049 |
| 5 | -2.0654 | 40.0216 | -0.1728 | 0.0065 | 0.0100 |
| 6 | -1.0133 | 39.0610 | -0.0983 | 0.0069 | 0.0028 |
| 7 | -0.0023 | 40.5836 | -0.0237 | 0.0083 | -0.0072 |
| 8 | 1.0470 | 40.6339 | 0.0525 | 0.0070 | 0.0029 |
| 9 | 2.0834 | 40.7542 | 0.1334 | 0.0083 | 0.0022 |
| 10 | 3.1529 | 40.7140 | 0.2145 | 0.0097 | 0.0089 |
| 11 | 4.1833 | 40.5735 | 0.2840 | 0.0133 | 0.0046 |
| 12 | 5.2486 | 40.8545 | 0.3647 | 0.0178 | 0.0073 |
| 13 | 6.2822 | 41.1657 | 0.4362 | 0.0238 | 0.0043 |
| 14 | 7.3203 | 40.7442 | 0.5085 | 0.0332 | -0.0076 |
| 15 | 8.3716 | 40.8746 | 0.5729 | 0.0438 | -0.0009 |
| 16 | 9.4025 | 41.3664 | 0.6384 | 0.0637 | -0.0107 |
| 17 | 10.4536 | 40.7542 | 0.6943 | 0.0922 | -0.0291 |
| 18 | 11.4654 | 40.7743 | 0.7299 | 0.1215 | -0.0525 |
| 19 | 12.4795 | 40.4832 | 0.7530 | 0.1509 | -0.0712 |
| 20 | 13.4730 | 39.8911 | 0.7588 | 0.1815 | -0.1003 |
| 21 | 14.4694 | 40.1219 | 0.7528 | 0.2043 | -0.1143 |
| 22 | 6.2810 | 41.0452 | 0.4310 | 0.0250 | -0.0040 |
| 23 | 4.1850 | 40.4531 | 0.2851 | 0.0144 | -0.0018 |
| 24 | 2.0951 | 40.9047 | 0.1280 | 0.0095 | -0.0071 |
| 25 | -0.0051 | 41.1657 | -0.0283 | 0.0094 | -0.0149 |
| 26 | -2.0721 | 39.9915 | -0.1821 | 0.0095 | -0.0083 |
| 27 | -4.1862 | 40.4832 | -0.3412 | 0.0157 | -0.0068 |

TABLE VII

AERODYNAMIC TARES OF RUN # 52703

| ROW # | AOA(DEG) | Q(PSF) | DCL | DCD | DCM-C/4 |
|---|---|---|---|---|---|
| 1 | -6.2505 | 39.4395 | -0.0101 | -0.0092 | 0.0203 |
| 2 | -5.2190 | 39.7807 | -0.0121 | -0.0106 | 0.0281 |
| 3 | -4.1657 | 39.4495 | -0.0085 | -0.0111 | 0.0280 |
| 4 | -3.1060 | 40.1219 | -0.0117 | -0.0109 | 0.0250 |
| 5 | -2.0654 | 40.0216 | -0.0134 | -0.0102 | 0.0197 |
| 6 | -1.0133 | 39.8610 | -0.0145 | -0.0102 | 0.0170 |
| 7 | -0.0023 | 40.5836 | -0.0172 | -0.0094 | 0.0100 |
| 8 | 1.0470 | 40.6839 | -0.0157 | -0.0100 | 0.0074 |
| 9 | 2.0834 | 40.7542 | -0.0178 | -0.0098 | 0.0049 |
| 10 | 3.1529 | 40.7140 | -0.0152 | -0.0103 | 0.0073 |
| 11 | 4.1833 | 40.5735 | -0.0172 | -0.0106 | 0.0062 |
| 12 | 5.2486 | 40.8545 | -0.0162 | -0.0104 | 0.0068 |
| 13 | 6.2822 | 41.1657 | -0.0188 | -0.0106 | 0.0061 |
| 14 | 7.3203 | 40.7442 | -0.0213 | -0.0103 | 0.0013 |
| 15 | 8.3716 | 40.8746 | -0.0214 | -0.0103 | 0.0013 |
| 16 | 9.4025 | 41.3664 | -0.0230 | -0.0112 | 0.0048 |
| 17 | 10.4536 | 40.7542 | -0.0214 | -0.0111 | 0.0031 |
| 18 | 11.4654 | 40.7743 | -0.0237 | -0.0112 | 0.0020 |
| 19 | 12.4795 | 40.4832 | -0.0243 | -0.0118 | 0.0041 |
| 20 | 13.4730 | 39.8911 | -0.0246 | -0.0115 | 0.0012 |
| 21 | 14.4694 | 40.1219 | -0.0248 | -0.0119 | 0.0005 |
| 22 | 6.2810 | 41.0452 | -0.0207 | -0.0099 | -0.0004 |
| 23 | 4.1850 | 40.4531 | -0.0187 | -0.0100 | 0.0026 |
| 24 | 2.0951 | 40.3047 | -0.0174 | -0.0090 | -0.0031 |
| 25 | -0.0051 | 41.1657 | -0.0170 | -0.0092 | 0.0082 |
| 26 | -2.0721 | 39.9915 | -0.0171 | -0.0087 | 0.0099 |
| 27 | -4.1862 | 40.4832 | -0.0158 | -0.0084 | 0.0095 |

## TABLE VIII

CORRECTED DATA OF RUN # 52702

| ROW # | AOA(DEG) | Q(PSF) | CL | CD | CM-C/4 |
|---|---|---|---|---|---|
| 1 | -6.2427 | 30.1529 | -0.4829 | 0.0238 | 0.0093 |
| 2 | -5.2126 | 30.8980 | -0.4108 | 0.0173 | 0.0187 |
| 3 | -4.1453 | 30.3039 | -0.3283 | 0.0108 | 0.0256 |
| 4 | -3.1054 | 30.6865 | -0.2464 | 0.0085 | 0.0096 |
| 5 | -2.0594 | 30.3945 | -0.1629 | 0.0066 | 0.0110 |
| 6 | -1.0084 | 30.5355 | -0.0894 | 0.0055 | 0.0101 |
| 7 | 0.0065 | 30.7369 | -0.0093 | 0.0073 | 0.0015 |
| 8 | 1.0417 | 30.5959 | 0.0688 | 0.0083 | -0.0038 |
| 9 | 2.0987 | 30.6060 | 0.1535 | 0.0080 | 0.0064 |
| 10 | 3.1618 | 30.7570 | 0.2275 | 0.0078 | 0.0267 |
| 11 | 4.1932 | 30.7671 | 0.3019 | 0.0112 | 0.0213 |
| 12 | 5.2570 | 30.8778 | 0.3769 | 0.0158 | 0.0257 |
| 13 | 6.2951 | 30.9785 | 0.4558 | 0.0226 | 0.0176 |
| 14 | 7.3239 | 30.7872 | 0.5177 | 0.0328 | 0.0013 |
| 15 | 8.3844 | 30.7570 | 0.5939 | 0.0452 | 0.0098 |
| 16 | 9.4051 | 30.6261 | 0.6443 | 0.0631 | 0.0027 |
| 17 | 10.4486 | 30.5858 | 0.7023 | 0.0922 | -0.0179 |
| 18 | 11.4685 | 30.5556 | 0.7351 | 0.1215 | -0.0430 |
| 19 | 12.4819 | 30.5758 | 0.7570 | 0.1514 | -0.0634 |
| 20 | 13.4732 | 30.1227 | 0.7591 | 0.1798 | -0.0897 |
| 21 | 14.4732 | 30.4549 | 0.7592 | 0.2059 | -0.1175 |
| 22 | 6.2910 | 30.5456 | 0.4491 | 0.0245 | -0.0015 |
| 23 | 4.1905 | 30.9061 | 0.2959 | 0.0132 | 0.0022 |
| 24 | 2.0844 | 30.4046 | 0.1301 | 0.0100 | -0.0094 |
| 25 | 0.0020 | 30.7570 | -0.0167 | 0.0101 | -0.0180 |
| 26 | -2.0688 | 30.7369 | -0.1750 | 0.0092 | -0.0076 |
| 27 | -4.1848 | 30.3643 | -0.3372 | 0.0136 | 0.0088 |

## TABLE IX

AERODYNAMIC TARES OF RUN # 52702

| ROW # | AOA(DEG) | Q(PSF) | DCL | DCD | DCM-C/4 |
|---|---|---|---|---|---|
| 1 | -6.2427 | 30.1529 | -0.0067 | -0.0094 | 0.0188 |
| 2 | -5.2126 | 30.8980 | -0.0097 | -0.0104 | 0.0240 |
| 3 | -4.1453 | 30.3039 | -0.0078 | -0.0119 | 0.0331 |
| 4 | -3.1054 | 30.6865 | -0.0087 | -0.0115 | 0.0287 |
| 5 | -2.0594 | 30.3945 | -0.0127 | -0.0101 | 0.0197 |
| 6 | -1.0084 | 30.5355 | -0.0101 | -0.0116 | 0.0250 |
| 7 | 0.0065 | 30.7369 | -0.0110 | -0.0104 | 0.0179 |
| 8 | 1.0417 | 30.5959 | -0.0094 | -0.0098 | 0.0054 |
| 9 | 2.0987 | 30.6060 | -0.0098 | -0.0109 | 0.0093 |
| 10 | 3.1618 | 30.7570 | -0.0124 | -0.0109 | 0.0104 |
| 11 | 4.1932 | 30.7671 | -0.0145 | -0.0114 | 0.0093 |
| 12 | 5.2570 | 30.8778 | -0.0121 | -0.0119 | 0.0145 |
| 13 | 6.2951 | 30.9785 | -0.0143 | -0.0116 | 0.0119 |
| 14 | 7.3239 | 30.7872 | -0.0149 | -0.0114 | 0.0068 |
| 15 | 8.3844 | 30.7570 | -0.0182 | -0.0120 | 0.0083 |
| 16 | 9.4051 | 30.6261 | -0.0199 | -0.0130 | 0.0115 |
| 17 | 10.4486 | 30.5858 | -0.0190 | -0.0124 | 0.0077 |
| 18 | 11.4685 | 30.5556 | -0.0210 | -0.0124 | 0.0054 |
| 19 | 12.4819 | 30.5758 | -0.0219 | -0.0129 | 0.0062 |
| 20 | 13.4732 | 30.1227 | -0.0223 | -0.0121 | 0.0010 |
| 21 | 14.4732 | 30.4549 | -0.0251 | -0.0120 | -0.0045 |
| 22 | 6.2910 | 30.5456 | -0.0187 | -0.0107 | 0.0000 |
| 23 | 4.1905 | 30.9081 | -0.0154 | -0.0102 | -0.0006 |
| 24 | 2.0844 | 30.4046 | -0.0156 | -0.0089 | -0.0078 |
| 25 | 0.0020 | 30.7570 | -0.0175 | -0.0093 | 0.0080 |
| 26 | -2.0688 | 30.7369 | -0.0151 | -0.0089 | 0.0085 |
| 27 | -4.1848 | 30.3643 | -0.0138 | -0.0088 | 0.0106 |

TABLE X

CORRECTED DATA OF RUN # 52701

| ROW # | AOA(DEG) | Q(PSF) | CL | CD | CM-C/4 |
|---|---|---|---|---|---|
| 1 | -6.2698 | 20.2376 | -0.5061 | 0.0256 | 0.0066 |
| 2 | -5.2260 | 20.0659 | -0.4310 | 0.0199 | 0.0054 |
| 3 | -4.1855 | 19.9346 | -0.3581 | 0.0141 | 0.0030 |
| 4 | -3.1238 | 19.6519 | -0.2751 | 0.0103 | 0.0095 |
| 5 | -2.0751 | 20.0659 | -0.1870 | 0.0057 | 0.0180 |
| 6 | -1.0229 | 19.9346 | -0.1132 | 0.0067 | 0.0068 |
| 7 | -0.0059 | 20.1265 | -0.0297 | 0.0085 | -0.0038 |
| 8 | 1.0464 | 19.9043 | 0.0515 | 0.0068 | 0.0157 |
| 9 | 2.0796 | 20.1568 | 0.1272 | 0.0041 | 0.0337 |
| 10 | 3.1475 | 20.0962 | 0.2073 | 0.0058 | 0.0422 |
| 11 | 4.1750 | 20.1770 | 0.2721 | 0.0086 | 0.0403 |
| 12 | 5.2513 | 20.0457 | 0.3709 | 0.0144 | 0.0376 |
| 13 | 6.2841 | 20.2275 | 0.4378 | 0.0204 | 0.0355 |
| 14 | 7.3462 | 19.9952 | 0.5149 | 0.0319 | 0.0106 |
| 15 | 8.3705 | 20.1770 | 0.5727 | 0.0428 | 0.0195 |
| 16 | 9.4025 | 20.0760 | 0.6400 | 0.0654 | 0.0033 |
| 17 | 10.4337 | 19.7428 | 0.6944 | 0.0951 | -0.0168 |
| 18 | 11.4662 | 19.9447 | 0.7312 | 0.1232 | -0.0373 |
| 19 | 12.4792 | 19.7629 | 0.7526 | 0.1531 | -0.0572 |
| 20 | 13.4718 | 19.8538 | 0.7568 | 0.1829 | -0.0900 |
| 21 | 14.4691 | 19.6519 | 0.7524 | 0.2050 | -0.1016 |
| 22 | 6.2839 | 20.0558 | 0.4373 | 0.0228 | 0.0095 |
| 23 | 4.1783 | 20.3386 | 0.2758 | 0.0113 | 0.0194 |
| 24 | 2.0749 | 19.8437 | 0.1195 | 0.0073 | 0.0084 |
| 25 | -0.0034 | 20.3284 | -0.0256 | 0.0118 | -0.0257 |
| 26 | -2.0942 | 20.1265 | -0.2183 | 0.0094 | -0.0056 |
| 27 | -4.2092 | 19.9548 | -0.3773 | 0.0161 | -0.0058 |

TABLE XI

AERODYNAMIC TARES OF RUN # 52701

| ROW # | AOA(DEG) | Q(PSF) | DCL | DCD | DCM-C/4 |
|---|---|---|---|---|---|
| 1 | -6.2698 | 20.2376 | -0.0084 | -0.0085 | 0.0173 |
| 2 | -5.2260 | 20.0659 | -0.0106 | -0.0076 | 0.0073 |
| 3 | -4.1855 | 19.9346 | -0.0096 | -0.0088 | 0.0093 |
| 4 | -3.1238 | 19.6519 | -0.0138 | -0.0096 | 0.0183 |
| 5 | -2.0751 | 20.0659 | -0.0148 | -0.0104 | 0.0285 |
| 6 | -1.0229 | 19.9346 | -0.0125 | -0.0114 | 0.0292 |
| 7 | -0.0059 | 20.1265 | -0.0166 | -0.0101 | 0.0200 |
| 8 | 1.0464 | 19.9043 | -0.0129 | -0.0105 | 0.0134 |
| 9 | 2.0796 | 20.1568 | -0.0169 | -0.0134 | 0.0243 |
| 10 | 3.1475 | 20.0962 | -0.0147 | -0.0138 | 0.0297 |
| 11 | 4.1750 | 20.1770 | -0.0142 | -0.0145 | 0.0295 |
| 12 | 5.2513 | 20.0457 | -0.0112 | -0.0135 | 0.0266 |
| 13 | 6.2841 | 20.2275 | -0.0170 | -0.0136 | 0.0267 |
| 14 | 7.3462 | 19.9952 | -0.0170 | -0.0117 | 0.0107 |
| 15 | 8.3705 | 20.1770 | -0.0175 | -0.0124 | 0.0146 |
| 16 | 9.4025 | 20.0760 | -0.0210 | -0.0140 | 0.0215 |
| 17 | 10.4337 | 19.7428 | -0.0183 | -0.0121 | 0.0104 |
| 18 | 11.4662 | 19.9447 | -0.0199 | -0.0133 | 0.0148 |
| 19 | 12.4792 | 19.7629 | -0.0190 | -0.0136 | 0.0163 |
| 20 | 13.4718 | 19.8538 | -0.0200 | -0.0134 | 0.0120 |
| 21 | 14.4691 | 19.6519 | -0.0194 | -0.0131 | 0.0077 |
| 22 | 6.2839 | 20.0558 | -0.0233 | -0.0110 | 0.0053 |
| 23 | 4.1783 | 20.3385 | -0.0198 | -0.0127 | 0.0175 |
| 24 | 2.0749 | 19.8437 | -0.0210 | -0.0103 | 0.0020 |
| 25 | -0.0034 | 20.3284 | -0.0218 | -0.0089 | 0.0104 |
| 26 | -2.0942 | 20.1265 | -0.0224 | -0.0080 | 0.0126 |
| 27 | -4.2092 | 19.9548 | -0.0217 | -0.0051 | -0.0151 |

## VI. CONCLUSIONS

### A. DATA ANALYSIS

Comparison of the three-strut mount and centerplate mount results was best achieved by inspection of the last three plots in the previous section. The lift curve, drag polar and pitching moment curve will again be examined in order.

The lift curve data for both runs yields essentially the same lift curve slope. The slope value of 0.072 $deg^{-1}$ compares favorably with the theoretical value of approximately 0.073 $deg^{-1}$. The centerplate mount yielded a $C_{Lmax}$ of 0.7588 vice 0.7210 for the three-strut mount. Direct comparison of the measured $C_{Lmax}$ was not possible because the test Reynolds numbers were less than those on available published data. It is, however, roughly estimated that the $C_{Lmax}$ attainable would be on the order of 0.8 and so close agreement is indicated. Possible cause for the centerplate to exhibit a higher $C_{Lmax}$ may be attributed to aerodynamically smoothing the wing attach points with modelling clay/tape and removal of the three-strut interference source. Curve fitting the data points for the centerplate case indicates that its curve may fall very slightly below the three-strut curve. This would yield a very small negative $C_L$ intercept for $\alpha = 0$. If the actual trace were lower, a possible cause might be a difference in bullet-fairing attitude with the wing-on adapter.

Inspection of the drag polar illustrated the need for accurate aerodynamic tares. The $C_{D_{min}}$ at $C_L = 0$ for the three-strut mount is 0.0250 compared to 0.0083 for the aerodynamically corrected centerplate coefficient. This is a gross discrepancy, and one which prompted the construction of a mount for which aerodynamic tares could be more easily acquired. Inspection for the drag tare at the corresponding angle of attack for this condition yielded a drag tare coefficient of 0.0094. This compares very favorably with the estimate of 0.0098 calculated in section IV, part F. Comparison of the centerplate $C_D$ value appears favorable with respect to section data corrected for aspect ratio, but again a direct comparison is not obtainable because of $R_N$ mismatch.

The effect of the unfaired aft strut "disappearing" into the floor was exhibited at higher angles of attack. For each increasingly higher angle of attack condition, the values of the respective $C_D$'s approached each other. The uncompensated contribution of the faired struts became small by comparison to the large $C_D$ measured, and the wetted area of the aft strut was reduced. When $C_L$ is plotted vs. $C_D$, this effect showed up as a tendency toward vertical stacking of the data points from both cases at the higher $C_L$'s.

Finally, inspection of the pitching moment curve reveals several notable discrepancies for the three-strut case, run 051501. The pronounced slope of the linear range indicates that the quarter chord point is aft of the actual aerodynamic

center location. Cause for this would be the detail accuracy required for a chord of 0.5 feet. An error of only a few hundredths of an inch readily shows up. The displacement of the curve to the right indicates the uncorrected interference effects of the three-strut mount, and possibly to a lesser extent, unavoidable limits on airfoil uniformity at this small scale. The airfoil is nominally accurate in contour to 0.001 inches to the quarter chord point and to 0.003 inches thereafter. The centerplate plot of run 052703 showed that marked improvement was available with aerodynamic tares. The relatively large scatter exhibited by the data points was attributed to the small scale and working close to the limits of the balance resolution.

Possible biasing was also noted for the centerplate pitching moment case, in that the repeatability check points predominantly fall to the right for each Q tested. Attempts at localizing this within the data were not conclusive, and the need for additional data points would be indicated for work in which a precise pitching moment was required. Resolution of $C_{M\bar{c}/4}$ inferred by the 27 data points of the presented runs is on the order of 0.005. The pitching moment curve for the centerplate mount does, however, show a considerable improvement over the three-strut mount in that it falls much closer to zero for its constant range. Also, the slope of the faired curve appeared more nearly vertical, indicating a better coincidence of the quarter-chord point with the wing

aerodynamic center. The scatter of the data points somewhat tempered this last observation. A possible fix for the scatter may involve a change of the drag-moment strain gauges on the modified balance to improve the conditioning of the reduction matrix as mentioned by Concannon in Ref. 1, pg. 59.

Summarizing, the centerplate mount has demonstrated a large improvement by incorporating readily attainable aerodynamic tares. The proof of concept experiment displayed excellent agreement with theoretical lift curve slope and indicated "predictable" tendencies for the drag polar and pitching moment curves. Mount flexibility was exhibited by readily adapting an existing calibration wing. The accuracy improvement available with centerplate mounting, coupled with an excellent data system and wall correction program, represents a powerful tool for academic endeavors and independent research on airframe configurations.

## B. RECOMMENDATIONS

The single most disturbing hardware problem involved in the study was the scatter of the data points for the pitching moment coefficient. While this parameter is among the hardest to accurately measure in a small wind tunnel, it is felt that the additional effort to change strain gauges may be warranted if tunnel utilization improves. The current resolution would suffice for any academic use, but the uncertainty may be too great for some engineering work requiring a very precise pitching moment coefficient.

The longest current delay in data reduction is the task of manually reentering all the raw data into the department's HP9830 computer for reduction. The microprocessor data acquisition system does have the capability for instant data reduction but at the loss of the raw data. It also has a punched paper tape output capability. It is felt that the raw data should be retained for system analysis and trouble shooting, but that some additional effort be invested toward interfacing the punched paper tape as a direct input to a software reduction program in one of the available, digital computers.

Further work remains to obtain more complete and current tunnel calibrations including pressure distributions and flow inclinations. It is also recommended that future studies in the tunnel include methods of Reynolds number compensation such as boundary layer tripping, since restricted Reynolds number capability is an inherent tunnel limitation.

Finally, it is felt that this study has contributed to the practicality of the tunnel and that the Department of Aeronautics will see greater utilization of this facility. It is hoped that the advances in modern tunnel research and improved capabilities of this tunnel recommend themselves for a larger share of the Department's curricula and research.

## APPENDIX A

## BASIC AERODYNAMIC AND TUNNEL RELATIONS

A raw data row consists of geometric angle of attack, dynamic pressure, and three strain gauge outputs that have been numerically averaged during a two second sampling interval. The first strain gauge output is directly proportional to lift. Configuration of the balance mixes the drag and moment, consequently, the remaining two strain gauges outputs must be resolved by a calibration matrix. The elements were determined by static loadings and correlation. The calibration matrix to convert gauges outputs in volts D.C. to lift drag and moment force in lbs. was:

$$\begin{Bmatrix} L \\ D \\ M \end{Bmatrix} = \begin{bmatrix} -96.154 & 0 & 0 \\ 0 & 17.500 & 25.575 \\ 0 & -89.065 & -66.070 \end{bmatrix} \begin{Bmatrix} L_1 \\ L_2 \\ L_3 \end{Bmatrix}$$

The coefficients generated by the reduction programs are the non-dimensional coefficients $C_L$, $C_D$, and $C_{M\bar{c}/4}$ given by the relations:

$$C_L = L/QS$$

$$C_D = D/QS$$

$$C_{M\bar{c}/4} = M\bar{c}/4/QS\bar{c}$$

$C_L$ was assumed as the independent variable and was only corrected for aerodynamic tares. Geometric angle of attack, and drag were corrected for wall corrections and aerodynamic tares. All data was corrected for wind-off dead weight zero readings and therefore, only the differential readings due to aerodynamic loading were reduced.

Wall corrections take the following form of those on pg. 341, 343 of Ref. 4:

$$\alpha_{aero} = \alpha_{geom} + \Delta\alpha$$

Where $\Delta\alpha = \frac{S}{C}\, 57.3\, C_L = 0.6102\, C_L$ deg.

$$C_D = C_{Du} + \Delta C_D$$

Where $\Delta C_D = \delta \frac{S}{C} C_L^{\,2} = 0.0106\, C_L^{\,2}$

S = Wing area, 1.5 $ft^2$

C = Tunnel cross-sectional area, 14.5 $ft^2$

$\delta$ = Tunnel factor given by Pope on pg. 343 of Ref. 2,

= 0.103 for the 3.5 x 5.0 octagonal configuration

$\Delta C_M$ was not utilized since the test was wing alone.

No tares other than dead weight were available for the three-strut mount. Wing-off runs were obtained to provide aerodynamic tares for the centerplate mount support situation.

## APPENDIX B

## MOUNT TRANSFER EQUATIONS

The focal line about which the three component balance resolves lift, drag and moment is centered 25.500 inches above the main beam and on the centerline of the tunnel test section. The three-strut mount wing trunnions are coincident with this axis and as long as the wing A.C. was also coincident no further corrections would be necessary. Plans of the calibration wing indicate that the A.C. was one-tenth inch above the focal axis at zero model angle when on the three-strut mount. The simple moment transfer resulted and the relation can be seen in figure 19.

$$C_M = C_M' - \frac{h}{\bar{c}} \cos\alpha \, C_D + \frac{h}{\bar{c}} \sin\alpha \, C_L$$

The main trunnion of the centerplate mount is necessarily below this focal axis and so the aerodynamic forces must be transferred from the model to the focal axis. This relation is slightly different since the pivot axis is not coincident with the focal axis. Also, the wing is located above the upper surface of the centerplate. The equation follows and the relation may be seen on figure 20.

$$C_M = C_M' + (h \sin\alpha \, C_L + (1.1667 - h \cos\alpha) C_D)/\bar{c}$$

Note that the above equations are in non-dimensional form and those on the figures were in dimensional form for the purpose of clarity. Dividing the figure equations by $QS\bar{c}$ would yield equivalent non-dimensional relations.

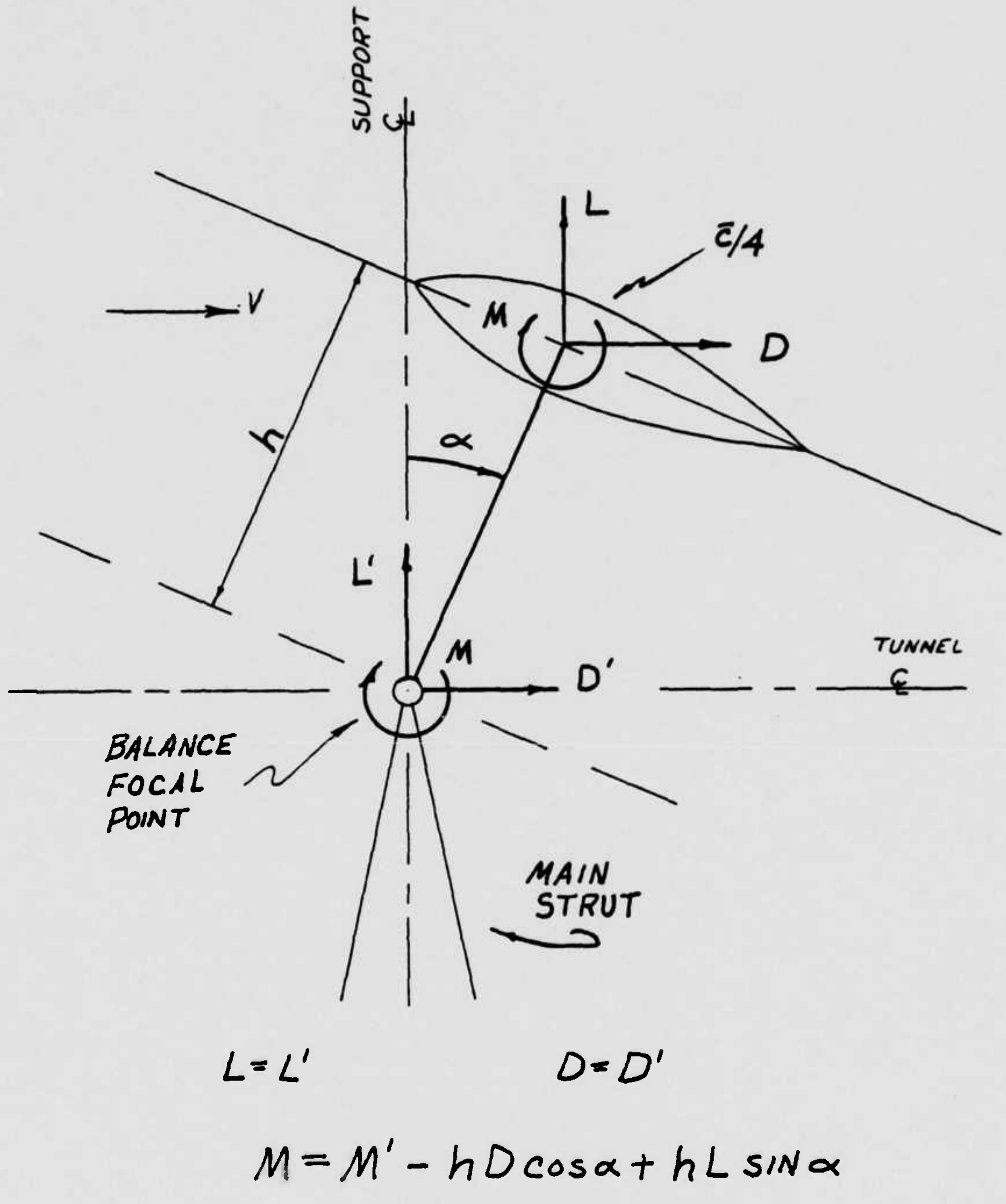
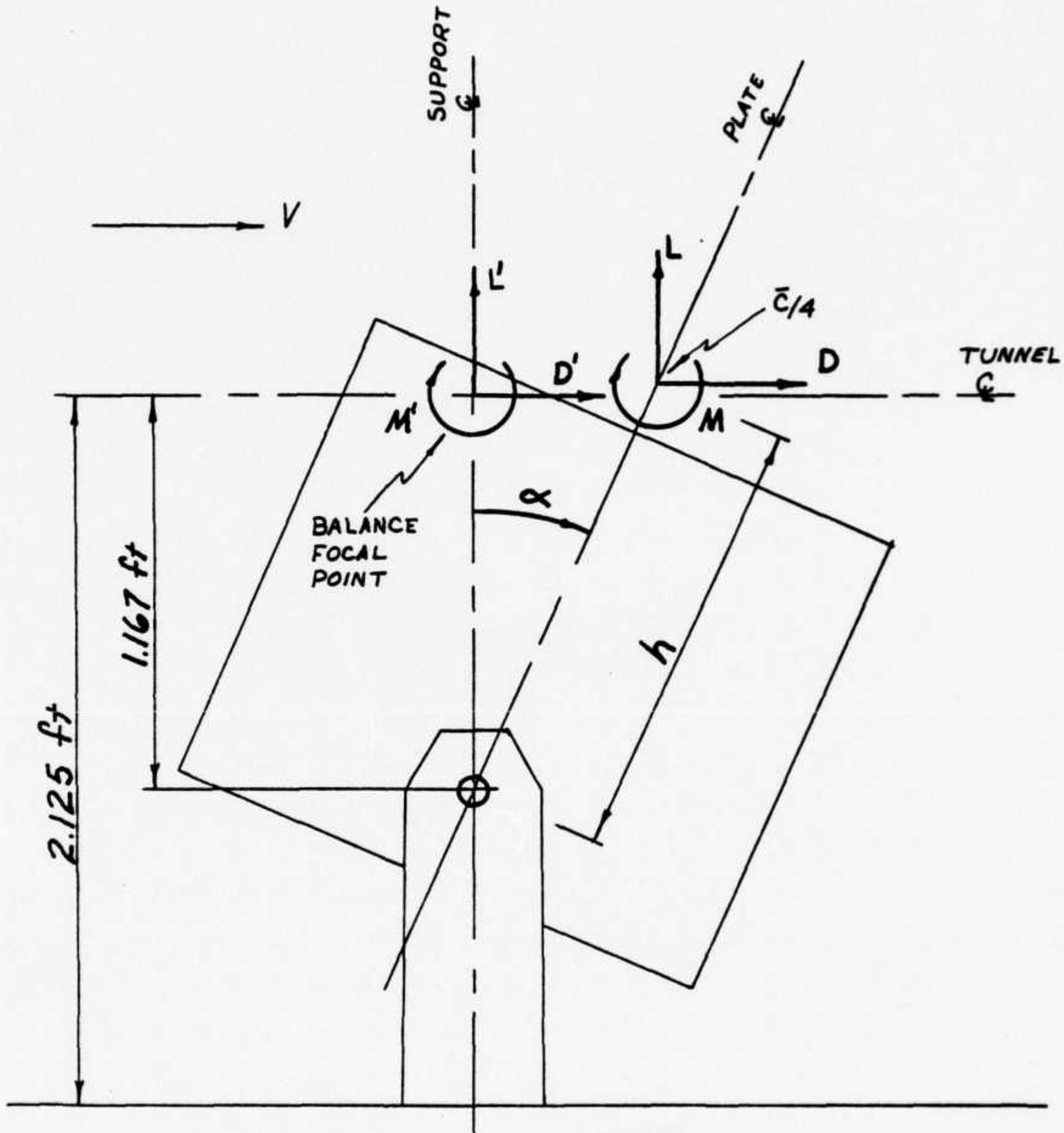



Figure 19. Three-strut moment transfer relations.




$L = L'$ $\qquad$ $D = D'$

$$M = M' + hL \sin\alpha + (1.167 - h\cos\alpha)D$$

Figure 20. Centerplate moment transfer relations.

# APPENDIX C

The following data was logged with a new microprocessor data acquisition system. The data variations in format and sequence represent a learning curve as familiarity with the system increased. Each run consists of a minimum of two wind-off zeros and 27 angle of attack conditions. Initial dead weight tares were taken at 21 conditions and two zero checks, but were later expanded to encompass the six extra check point conditions for fully redundant repeatability checks. The initial and final wind-off zeros for runs on the 18th of May were included in the calculation of each run's data. Thereafter, individual wind-off zeros were taken with each run or were repeated as the final and initial data rows in consecutive runs. Initial and final wind-on data rows for the runs of the 27th of May were checked for consistency and then dropped from reduction as the zero point was already redundant within the 27 reduced data rows. In initial weight tare runs for which the precise angle of attack was not required, the angle of attack values were rounded to the nearest integer to speed data entry. Slight deviation between raw data and computer storage values only reflects HP9830 computer rounding for fixed -4 format and not the stored value.

Wind-on to wind-off times for the 27 angle of attack positions settled to about eight minutes with manual angle of attack settings. Programmed microprocessor setting promises to reduce this interval by a factor of one half.

The computer file record of each data group immediately follows the respective raw data.

TABLE XII

RUN NO: 051501 .. 15 MAY 1977
3 STRUT SUPPORT CALIB. WING

READY
SCAN

| # | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 030 | -.6007 | 4.397 | .5125 | 6.794E-02 | .4039 |
| 031 | -.4986 | 4.427 | .4633 | 8.827E-02 | .3751 |
| 032 | -.3979 | 4.405 | .4093 | .1054 | .3544 |
| 033 | -.2978 | 4.358 | .3591 | .1195 | .3329 |
| 034 | -.1966 | 4.461 | .3135 | .1262 | .3262 |
| 035 | -9.753E-02 | 4.507 | .2613 | .1303 | .3189 |
| 036 | 1.213E-03 | 4.470 | .2111 | .1340 | .3142 |
| 037 | .1016 | 4.427 | .1585 | .1348 | .3125 |
| 038 | .1970 | 4.474 | .1135 | .1321 | .3161 |
| 039 | .2990 | 4.510 | 6.167E-02 | .1264 | .3235 |
| 040 | .4006 | 4.548 | 1.196E-02 | .1169 | .3347 |
| 041 | .4994 | 4.583 | -3.835E-02 | .1047 | .3528 |
| 042 | .6012 | 4.530 | -8.222E-02 | 8.964E-02 | .3727 |
| 043 | .7029 | 4.568 | -.1358 | 7.084E-02 | .3989 |
| 044 | .8017 | 4.560 | -.1777 | 3.720E-02 | .4443 |
| 045 | .8985 | 4.492 | -.2082 | -1.807E-02 | .5228 |
| 046 | .9999 | 4.461 | -.2343 | -.1020 | .6419 |
| 047 | 1.104 | 4.381 | -.2438 | -.1905 | .7706 |
| 048 | 1.207 | 4.370 | -.2503 | -.2829 | .9039 |
| 049 | 1.301 | 4.400 | -.2479 | -.3637 | 1.021 |
| 050 | 1.400 | 4.291 | -.2285 | -.4160 | 1.098 |
| 051 | .6013 | 4.485 | -7.762E-02 | 9.221E-02 | .3690 |
| 052 | .3977 | 4.391 | 2.206E-02 | .1200 | .3316 |
| 053 | .2003 | 4.402 | .1144 | .1340 | .3130 |
| 054 | [illegible].343E-03 | 4.353 | .2119 | .1366 | .3110 |
| 055 | -.1984 | 4.197 | .3090 | .1319 | .3164 |
| 056 | -.3946 | 4.258 | .4065 | .1113 | .3466 |
| 057 | 1.223E-03 | -7.123E-03 | .2062 | .2029 | .2051 |
| 058 | | | | | |

TABLE XIII

RUN NO: 51501

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0007 | 0.0006 | 0.2071 | 0.2035 | 0.2053 |
| 2 | -0.6007 | 4.3970 | 0.5125 | 0.0679 | 0.4039 |
| 3 | -0.4986 | 4.4270 | 0.4633 | 0.0883 | 0.3751 |
| 4 | -0.3979 | 4.4050 | 0.4093 | 0.1054 | 0.3544 |
| 5 | -0.2978 | 4.3580 | 0.3591 | 0.1195 | 0.3329 |
| 6 | -0.1966 | 4.4610 | 0.3135 | 0.1262 | 0.3262 |
| 7 | -0.0975 | 4.5070 | 0.2613 | 0.1303 | 0.3189 |
| 8 | 0.0012 | 4.4700 | 0.2111 | 0.1340 | 0.3142 |
| 9 | 0.1016 | 4.4270 | 0.1585 | 0.1348 | 0.3125 |
| 10 | 0.1970 | 4.4740 | 0.1135 | 0.1321 | 0.3161 |
| 11 | 0.2990 | 4.5100 | 0.0617 | 0.1264 | 0.3235 |
| 12 | 0.4006 | 4.5480 | 0.0120 | 0.1169 | 0.3347 |
| 13 | 0.4994 | 4.5830 | -0.0384 | 0.1047 | 0.3528 |
| 14 | 0.6012 | 4.5300 | -0.0822 | 0.0896 | 0.3727 |
| 15 | 0.7029 | 4.5680 | -0.1358 | 0.0708 | 0.3989 |
| 16 | 0.8017 | 4.5600 | -0.1777 | 0.0372 | 0.4443 |
| 17 | 0.8985 | 4.4920 | -0.2082 | -0.0181 | 0.5228 |
| 18 | 0.9999 | 4.4610 | -0.2343 | -0.1020 | 0.6419 |
| 19 | 1.1040 | 4.3810 | -0.2438 | -0.1905 | 0.7706 |
| 20 | 1.2070 | 4.3700 | -0.2503 | -0.2829 | 0.9039 |
| 21 | 1.3010 | 4.4000 | -0.2479 | -0.3637 | 1.0210 |
| 22 | 1.4000 | 4.2910 | -0.2285 | -0.4160 | 1.0980 |
| 23 | 0.6013 | 4.4850 | -0.0776 | 0.0922 | 0.3690 |
| 24 | 0.3977 | 4.3910 | 0.0221 | 0.1200 | 0.3316 |
| 25 | 0.2003 | 4.4020 | 0.1144 | 0.1340 | 0.3130 |
| 26 | 0.0023 | 4.3530 | 0.2119 | 0.1366 | 0.3110 |
| 27 | -0.1984 | 4.1970 | 0.3090 | 0.1319 | 0.3164 |
| 28 | -0.3946 | 4.2580 | 0.4065 | 0.1113 | 0.3466 |
| 29 | 0.0012 | -0.0071 | 0.2062 | 0.2029 | 0.2051 |

RUN # 51501 DATA IS STORED IN FILE# 8

TABLE XIV

RUN NO: STATIC CALIB. ... 15 MAY 1977 AT 1605

READY
SCAN

| # | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 006 | 1.223E-03 | 1.242E-03 | .2049 | .2019 | .2050 |
| 007 | -.6034 | 1.223E-03 | .2053 | .2018 | .2046 |
| 008 | -.5001 | 1.232E-03 | .2059 | .2017 | .2064 |
| 009 | -.4000 | 1.223E-03 | .2048 | .2019 | .2063 |
| 010 | -.3018 | 1.223E-03 | .2052 | .2020 | .2060 |
| 011 | -.1968 | 1.223E-03 | .2059 | .2021 | .2056 |
| 012 | -9.770E-02 | 1.223E-03 | .2056 | .2024 | .2043 |
| 013 | -1.495E-03 | 1.223E-03 | .2058 | .2028 | .2057 |
| 014 | 9.870E-02 | 1.223E-03 | .2064 | .2030 | .2048 |
| 015 | .2001 | 1.223E-03 | .2057 | .2035 | .2067 |
| 016 | .3019 | 1.223E-03 | .2054 | .2039 | .2063 |
| 017 | .4006 | 1.223E-03 | .2059 | .2044 | .2048 |
| 018 | .5020 | 1.223E-03 | .2063 | .2051 | .2061 |
| 019 | .6039 | 1.223E-03 | .2062 | .2058 | .2053 |
| 020 | .7003 | 1.194E-03 | .2063 | .2062 | .2056 |
| 021 | .8043 | 1.194E-03 | .2065 | .2066 | .2035 |
| 022 | .9034 | 1.137E-03 | .2069 | .2073 | .2024 |
| 023 | 1.002 | 1.099E-03 | .2067 | .2084 | .2031 |
| 024 | 1.100 | 1.070E-03 | .2063 | .2096 | .2020 |
| 025 | 1.203 | 5.264E-04 | .2063 | .2104 | .2005 |
| 026 | 1.300 | 7.648E-04 | .2064 | .2113 | .2009 |
| 027 | 1.403 | 1.450E-04 | .2062 | .2124 | .2005 |
| 028 | 7.362E-04 | 5.836E-04 | .2071 | .2035 | .2053 |
| 029 | | | | | |

## TABLE XV

RUN NO: 51577

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.2049 | 0.2019 | 0.2050 |
| 2 | -6.0000 | 0.0000 | 0.2053 | 0.2018 | 0.2046 |
| 3 | -5.0000 | 0.0000 | 0.2059 | 0.2017 | 0.2064 |
| 4 | -4.0000 | 0.0000 | 0.2048 | 0.2019 | 0.2063 |
| 5 | -3.0000 | 0.0000 | 0.2052 | 0.2020 | 0.2060 |
| 6 | -2.0000 | 0.0000 | 0.2059 | 0.2021 | 0.2056 |
| 7 | -1.0000 | 0.0000 | 0.2056 | 0.2024 | 0.2043 |
| 8 | 0.0000 | 0.0000 | 0.2058 | 0.2028 | 0.2057 |
| 9 | 1.0000 | 0.0000 | 0.2064 | 0.2030 | 0.2048 |
| 10 | 2.0000 | 0.0000 | 0.2057 | 0.2035 | 0.2067 |
| 11 | 3.0000 | 0.0000 | 0.2054 | 0.2039 | 0.2063 |
| 12 | 4.0000 | 0.0000 | 0.2059 | 0.2044 | 0.2048 |
| 13 | 5.0000 | 0.0000 | 0.2063 | 0.2051 | 0.2061 |
| 14 | 6.0000 | 0.0000 | 0.2062 | 0.2058 | 0.2053 |
| 15 | 7.0000 | 0.0000 | 0.2063 | 0.2062 | 0.2056 |
| 16 | 8.0000 | 0.0000 | 0.2065 | 0.2066 | 0.2035 |
| 17 | 9.0000 | 0.0000 | 0.2069 | 0.2073 | 0.2024 |
| 18 | 10.0000 | 0.0000 | 0.2067 | 0.2084 | 0.2031 |
| 19 | 11.0000 | 0.0000 | 0.2063 | 0.2096 | 0.2020 |
| 20 | 12.0000 | 0.0000 | 0.2063 | 0.2104 | 0.2005 |
| 21 | 13.0000 | 0.0000 | 0.2064 | 0.2113 | 0.2009 |
| 22 | 14.0000 | 0.0000 | 0.2062 | 0.2124 | 0.2005 |
| 23 | 6.0000 | 0.0000 | 0.2062 | 0.2058 | 0.2053 |
| 24 | 4.0000 | 0.0000 | 0.2059 | 0.2044 | 0.2048 |
| 25 | 2.0000 | 0.0000 | 0.2057 | 0.2035 | 0.2067 |
| 26 | 0.0000 | 0.0000 | 0.2058 | 0.2028 | 0.2057 |
| 27 | -2.0000 | 0.0000 | 0.2059 | 0.2021 | 0.2056 |
| 28 | -4.0000 | 0.0000 | 0.2048 | 0.2019 | 0.2063 |
| 29 | 0.0000 | 0.0000 | 0.2071 | 0.2035 | 0.2053 |

RUN # 51577   DATA IS STOPED IN FILE# 7

TABLE XVI

RUN 51801, Q=40 PSF

@
READY
SCAN

| # | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 037 | -.5973 | 4.392 | .5060 | 6.868E-02 | .3980 |
| 038 | -.4986 | 4.291 | .4536 | 9.063E-02 | .3675 |
| ~~039~~ | ~~-.3926~~ | ~~4.379~~ | ~~.4044~~ | ~~.1068~~ | ~~.3483~~ |
| 040 | -.3979 | 4.387 | .4081 | .1065 | .3462 |
| 041 | -.2990 | 4.243 | .3514 | .1210 | .3262 |
| 042 | -.1966 | 4.240 | .3044 | .1291 | .3157 |
| 043 | -9.740E-02 | 4.402 | .2611 | .1319 | .3118 |
| 044 | 1.232E-03 | 4.399 | .2077 | .1342 | .3091 |
| 045 | .1015 | 4.387 | .1597 | .1338 | .3092 |
| 046 | .2002 | 4.487 | .1081 | .1307 | .3126 |
| 047 | .3000 | 4.444 | 5.973E-02 | .1263 | .3178 |
| 048 | .4007 | 4.481 | 1.063E-02 | .1177 | .3302 |
| 049 | .4994 | 4.459 | -3.304E-02 | .1064 | .3467 |
| 050 | .6015 | 4.471 | -8.295E-02 | 9.153E-02 | .3675 |
| 051 | .7004 | 4.454 | -.1296 | 7.331E-02 | .3906 |
| 052 | .8007 | 4.497 | -.1739 | 3.828E-02 | .4331 |
| 053 | .9008 | 4.451 | -.2074 | -1.848E-02 | .5215 |
| 054 | 1.000 | 4.465 | -.2376 | -.1050 | .6442 |
| 055 | 1.102 | 4.438 | -.2523 | -.1958 | .7757 |
| 056 | 1.201 | 4.457 | -.2647 | -.2884 | .9092 |
| 057 | 1.300 | 4.353 | -.2516 | -.3563 | 1.0[illegible]7 |
| 05[illegible] | 1.400 | 4.339 | -.2289 | -.4160 | 1.093 |
| 059 | .5984 | 4.422 | -7.739E-02 | 9.221E-02 | .3648 |
| 060 | .4007 | 4.496 | 1.222E-02 | .1171 | .3314 |
| 061 | .2002 | 4.411 | .1137 | .1318 | .3116 |
| 062 | 1.223E-03 | 4.386 | .2046 | .1341 | .3091 |
| 063 | -.1967 | 4.255 | .3059 | .1302 | .3143 |
| 064 | -.3979 | 4.351 | .4101 | .1073 | .3477 |
| 065 | 1.223E-03 | 4.329 | .2091 | .1354 | .3071 |
| 066 | | | | | |

TABLE XVII

RUN NO: 51801

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0012 | 0.0013 | 0.2035 | 0.2034 | 0.2034 |
| 2 | -0.5973 | 4.3920 | 0.5060 | 0.0687 | 0.3980 |
| 3 | -0.4986 | 4.2910 | 0.4536 | 0.0906 | 0.3675 |
| 4 | -0.3979 | 4.3870 | 0.4081 | 0.1065 | 0.3462 |
| 5 | -0.2990 | 4.2430 | 0.3514 | 0.1210 | 0.3262 |
| 6 | -0.1966 | 4.2400 | 0.3044 | 0.1291 | 0.3157 |
| 7 | -0.0974 | 4.4020 | 0.2611 | 0.1319 | 0.3118 |
| 8 | 0.0012 | 4.3990 | 0.2077 | 0.1342 | 0.3091 |
| 9 | 0.1015 | 4.3870 | 0.1597 | 0.1338 | 0.3092 |
| 10 | 0.2002 | 4.4870 | 0.1081 | 0.1307 | 0.3126 |
| 11 | 0.3000 | 4.4440 | 0.0597 | 0.1263 | 0.3178 |
| 12 | 0.4007 | 4.4810 | 0.0106 | 0.1177 | 0.3302 |
| 13 | 0.4994 | 4.4590 | -0.0330 | 0.1064 | 0.3467 |
| 14 | 0.6015 | 4.4710 | -0.0830 | 0.0915 | 0.3675 |
| 15 | 0.7004 | 4.4540 | -0.1296 | 0.0733 | 0.3906 |
| 16 | 0.8007 | 4.4970 | -0.1739 | 0.0383 | 0.4381 |
| 17 | 0.9008 | 4.4510 | -0.2074 | -0.0185 | 0.5215 |
| 18 | 1.0000 | 4.4650 | -0.2376 | -0.1050 | 0.6442 |
| 19 | 1.1020 | 4.4380 | -0.2523 | -0.1958 | 0.7757 |
| 20 | 1.2010 | 4.4570 | -0.2647 | -0.2884 | 0.9092 |
| 21 | 1.3000 | 4.3530 | -0.2516 | -0.3563 | 1.0070 |
| 22 | 1.4000 | 4.3390 | -0.2289 | -0.4160 | 1.0930 |
| 23 | 0.5984 | 4.4220 | -0.0774 | 0.0922 | 0.3648 |
| 24 | 0.4007 | 4.4960 | 0.0122 | 0.1171 | 0.3314 |
| 25 | 0.2002 | 4.4110 | 0.1137 | 0.1318 | 0.3116 |
| 26 | 0.0012 | 4.3860 | 0.2046 | 0.1341 | 0.3091 |
| 27 | -0.1967 | 4.2550 | 0.3059 | 0.1302 | 0.3143 |
| 28 | -0.3979 | 4.3510 | 0.4101 | 0.1073 | 0.3477 |
| 29 | 0.0012 | 0.0166 | 0.2015 | 0.2021 | 0.2033 |

RUN # 51801 DATA IS STORED IN FILE# 10

TABLE XVIII

RUN 51802, Q=30 PSF

●
READY
SCAN

| # | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 067 | -.5947 | 3.242 | .4246 | .1060 | .3440 |
| 068 | -.4963 | 3.207 | .3883 | .1210 | .3213 |
| 069 | -.3978 | 3.184 | .3526 | .1345 | .3047 |
| 070 | -.2992 | 3.238 | .3145 | .1423 | .2938 |
| 071 | -.1967 | 3.178 | .2754 | .1498 | .2833 |
| 072 | -9.757E-02 | 3.214 | .2429 | .1529 | .2785 |
| 073 | 1.165E-03 | 3.254 | .2075 | .1546 | .2755 |
| 074 | .1015 | 3.182 | .1699 | .1553 | .2747 |
| 075 | .2002 | 3.288 | .1312 | .1525 | .2787 |
| 076 | .2991 | 3.285 | 9.801E-02 | .1482 | .2849 |
| 077 | .4005 | 3.289 | 6.402E-02 | .1415 | .2934 |
| 078 | .5008 | 3.293 | 2.374E-02 | .1330 | .3057 |
| 079 | .5984 | 3.320 | -9.879E-03 | .1228 | .3207 |
| 080 | .7005 | 3.288 | -4.445E-02 | .1079 | .3419 |
| 081 | .7994 | 3.256 | -7.017E-02 | 8.226E-02 | .3761 |
| 082 | .9038 | 3.309 | -.1009 | 3.514E-02 | .4397 |
| 083 | 1.003 | 3.294 | -.1202 | -2.544E-02 | .5317 |
| 084 | 1.099 | 3.240 | -.1308 | -8.801E-02 | .6225 |
| 085 | 1.201 | 3.221 | -.1322 | -.1511 | .7141 |
| 086 | 1.298 | 3.240 | -.1326 | -.2111 | .8002 |
| 087 | 1.400 | 3.259 | -.1259 | -.2646 | .8783 |
| 088 | .5982 | 3.313 | -7.171E-03 | .1229 | .3214 |
| 089 | .4007 | 3.272 | 6.359E-02 | .1426 | .2939 |
| 090 | .2002 | 3.320 | .1370 | .1519 | .2826 |
| 091 | 1.223E-03 | 3.309 | .2078 | .1539 | .2793 |
| 092 | -.1966 | 3.294 | .2797 | .1490 | .2863 |
| 093 | -.3979 | 3.260 | .3575 | .1328 | .3072 |
| 094 | | | | | |

TABLE XIX

RUN NO: 51802

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0012 | 0.0013 | 0.2035 | 0.2034 | 0.2034 |
| 2 | -0.5947 | 3.2420 | 0.4246 | 0.1060 | 0.3440 |
| 3 | -0.4963 | 3.2070 | 0.3883 | 0.1210 | 0.3213 |
| 4 | -0.3979 | 3.1840 | 0.3526 | 0.1345 | 0.3047 |
| 5 | -0.2992 | 3.2380 | 0.3145 | 0.1423 | 0.2938 |
| 6 | -0.1967 | 3.1780 | 0.2754 | 0.1498 | 0.2833 |
| 7 | -0.0976 | 3.2140 | 0.2429 | 0.1529 | 0.2785 |
| 8 | 0.0012 | 3.2540 | 0.2075 | 0.1546 | 0.2755 |
| 9 | 0.1015 | 3.1820 | 0.1699 | 0.1553 | 0.2747 |
| 10 | 0.2002 | 3.2880 | 0.1312 | 0.1525 | 0.2787 |
| 11 | 0.2991 | 3.2850 | 0.0980 | 0.1482 | 0.2849 |
| 12 | 0.4005 | 3.2890 | 0.0640 | 0.1415 | 0.2934 |
| 13 | 0.5008 | 3.2930 | 0.0237 | 0.1330 | 0.3057 |
| 14 | 0.5984 | 3.3200 | -0.0099 | 0.1228 | 0.3207 |
| 15 | 0.7005 | 3.2880 | -0.0445 | 0.1079 | 0.3419 |
| 16 | 0.7994 | 3.2560 | -0.0702 | 0.0823 | 0.3761 |
| 17 | 0.9038 | 3.3090 | -0.1009 | 0.0351 | 0.4397 |
| 18 | 1.0030 | 3.2940 | -0.1202 | -0.0254 | 0.5317 |
| 19 | 1.0990 | 3.2400 | -0.1308 | -0.0880 | 0.6225 |
| 20 | 1.2010 | 3.2210 | -0.1322 | -0.1511 | 0.7141 |
| 21 | 1.2980 | 3.2400 | -0.1326 | -0.2111 | 0.8002 |
| 22 | 1.4000 | 3.2590 | -0.1259 | -0.2646 | 0.8783 |
| 23 | 0.5982 | 3.3130 | -0.0072 | 0.1229 | 0.3214 |
| 24 | 0.4007 | 3.2720 | 0.0636 | 0.1426 | 0.2939 |
| 25 | 0.2002 | 3.3200 | 0.1370 | 0.1519 | 0.2826 |
| 26 | 0.0012 | 3.3090 | 0.2078 | 0.1539 | 0.2793 |
| 27 | -0.1966 | 3.2940 | 0.2797 | 0.1490 | 0.2863 |
| 28 | -0.3979 | 3.2600 | 0.3575 | 0.1328 | 0.3072 |
| 29 | 0.0012 | 0.0166 | 0.2015 | 0.2021 | 0.2033 |

RUN # 51802 DATA IS STORED IN FILE# 11

TABLE XX

RUN 51803, Q=20 PSF

@
READY
SCAN

| # | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 095 | -.5974 | 2.164 | .3586 | .1423 | .2915 |
| 096 | -.4962 | 2.194 | .3356 | .1503 | .2796 |
| 097 | -.3979 | 2.230 | .3149 | .1570 | .2719 |
| 098 | -.2992 | 2.185 | .2861 | .1643 | .2601 |
| 099 | -.1966 | 2.171 | .2610 | .1693 | .2543 |
| 000 | -9.751E-02 | 2.213 | .2341 | .1706 | .2522 |
| 001 | 1.223E-03 | 2.221 | .2096 | .1715 | .2522 |
| 002 | 9.852E-02 | 2.230 | .1850 | .1711 | .2516 |
| 003 | .1997 | 2.239 | .1568 | .1700 | .2524 |
| 004 | .2991 | 2.217 | .1341 | .1672 | .2559 |
| 005 | .3992 | 2.231 | .1105 | .1624 | .2618 |
| 006 | .4994 | 2.255 | 8.094E-02 | .1569 | .2710 |
| 007 | .6014 | 2.217 | 6.025E-02 | .1503 | .2793 |
| 008 | .7003 | 2.263 | 3.254E-02 | .1381 | .2961 |
| 009 | .8018 | 2.214 | 1.452E-02 | .1196 | .3208 |
| 010 | .9005 | 2.244 | 6.504E-04 | 9.240E-02 | .3573 |
| 011 | 1.0000 | 2.254 | -1.678E-02 | 4.410E-02 | .4272 |
| 012 | 1.100 | 2.186 | -1.699E-02 | 4.942E-03 | .4857 |
| 013 | 1.201 | 2.201 | -2.224E-02 | -3.561E-02 | .5487 |
| 014 | 1.301 | 2.200 | -2.173E-02 | -7.521E-02 | .6077 |
| 015 | 1.400 | 2.208 | -1.462E-02 | -.1074 | .6547 |
| 016 | .6015 | 2.239 | 5.906E-02 | .1505 | .2801 |
| 017 | .4005 | 2.219 | .1076 | .1642 | .2603 |
| 018 | .2001 | 2.228 | .1617 | .1699 | .2530 |
| 019 | 1.223E-03 | 2.208 | .2107 | .1721 | .2506 |
| 020 | -.1965 | 2.228 | .2632 | .1686 | .2558 |
| 021 | -.3978 | 2.183 | .3136 | .1579 | .2696 |
| 022 | 1.223E-03 | 1.639E-02 | .2017 | .2013 | .2027 |
| 023 | | | | | |
| | 1.223E-03 | 1.662E-02 | .2015 | .2021 | .2033 |
| 024 | | | | | |

TABLE XXI

RUN NO: 51303

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0012 | 0.0013 | 0.2035 | 0.2034 | 0.2034 |
| 2 | -0.5974 | 2.1640 | 0.3586 | 0.1423 | 0.2915 |
| 3 | -0.4962 | 2.1940 | 0.3356 | 0.1503 | 0.2796 |
| 4 | -0.3979 | 2.2300 | 0.3149 | 0.1570 | 0.2719 |
| 5 | -0.2992 | 2.1850 | 0.2861 | 0.1643 | 0.2601 |
| 6 | -0.1966 | 2.1710 | 0.2610 | 0.1693 | 0.2543 |
| 7 | -0.0975 | 2.2130 | 0.2341 | 0.1706 | 0.2522 |
| 8 | 0.0012 | 2.2210 | 0.2096 | 0.1715 | 0.2522 |
| 9 | 0.0985 | 2.2300 | 0.1850 | 0.1711 | 0.2516 |
| 10 | 0.1997 | 2.2390 | 0.1568 | 0.1700 | 0.2524 |
| 11 | 0.2991 | 2.2170 | 0.1341 | 0.1672 | 0.2559 |
| 12 | 0.3992 | 2.2310 | 0.1105 | 0.1624 | 0.2618 |
| 13 | 0.4994 | 2.2550 | 0.0809 | 0.1569 | 0.2710 |
| 14 | 0.6014 | 2.2170 | 0.0603 | 0.1503 | 0.2793 |
| 15 | 0.7003 | 2.2630 | 0.0325 | 0.1381 | 0.2961 |
| 16 | 0.8018 | 2.2140 | 0.0145 | 0.1196 | 0.3208 |
| 17 | 0.9005 | 2.2440 | 0.0007 | 0.0924 | 0.3573 |
| 18 | 1.0000 | 2.2540 | -0.0168 | 0.0441 | 0.4272 |
| 19 | 1.1000 | 2.1860 | -0.0170 | 0.0049 | 0.4857 |
| 20 | 1.2010 | 2.2010 | -0.0222 | -0.0356 | 0.5487 |
| 21 | 1.3010 | 2.2000 | -0.0217 | -0.0752 | 0.6077 |
| 22 | 1.4000 | 2.2080 | -0.0146 | -0.1074 | 0.6547 |
| 23 | 0.6015 | 2.2390 | 0.0591 | 0.1505 | 0.2801 |
| 24 | 0.4005 | 2.2190 | 0.1076 | 0.1642 | 0.2603 |
| 25 | 0.2001 | 2.2280 | 0.1617 | 0.1699 | 0.2530 |
| 26 | 0.0012 | 2.2080 | 0.2107 | 0.1721 | 0.2506 |
| 27 | -0.1965 | 2.2280 | 0.2632 | 0.1686 | 0.2558 |
| 28 | -0.3978 | 2.1830 | 0.3136 | 0.1579 | 0.2696 |
| 29 | 0.0012 | 0.0166 | 0.2015 | 0.2021 | 0.2033 |

RUN # 51303 DATA IS STORED IN FILE# 12

TABLE XXII

18 MAY 1977 WIND OFF BALANCE READINGS 1500

)@
READY
SCAN

| # | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 006 | 1.223E-03 | 1.223E-03 | .2010 | .2019 | .2032 |
| 007 | -.6006 | 1.223E-03 | .2014 | .2015 | .2038 |
| 008 | -.4986 | 1.223E-03 | .2012 | .2015 | .2034 |
| 009 | -.3997 | 1.223E-03 | .2014 | .2017 | .2041 |
| 010 | -.2987 | 1.223E-03 | .2016 | .2016 | .2054 |
| 011 | -.1995 | 1.223E-03 | .2019 | .2020 | .2034 |
| 012 | -9.728E-02 | 1.232E-03 | .2022 | .2023 | .2042 |
| 013 | 1.223E-03 | 1.223E-03 | .2026 | .2028 | .2031 |
| 014 | .1016 | 1.223E-03 | .2019 | .2029 | .2030 |
| 015 | .2001 | 1.232E-03 | .2019 | .2035 | .2020 |
| 016 | .2992 | 1.242E-03 | .2030 | .2042 | .2025 |
| 017 | .4007 | 1.223E-03 | .2021 | .2045 | .2022 |
| 018 | .4994 | 1.223E-03 | .2030 | .2052 | .2017 |
| 019 | .6021 | 1.270E-03 | .2032 | .2059 | .2024 |
| 020 | .7003 | 1.280E-03 | .2025 | .2062 | .2017 |
| 021 | .7998 | 1.242E-03 | .2028 | .2068 | .2005 |
| 022 | .9009 | 1.280E-03 | .2033 | .2077 | .2001 |
| 023 | 1.000 | 1.261E-03 | .2026 | .2086 | .2007 |
| 024 | 1.100 | 1.251E-03 | .2030 | .2095 | .1990 |
| 025 | 1.201 | 1.404E-03 | .2035 | .2107 | .1977 |
| 026 | 1.300 | 1.299E-03 | .2023 | .2113 | .1979 |
| 027 | 1.400 | 1.308E-03 | .2028 | .2124 | .1964 |
| 028 | .5982 | 1.289E-03 | .2034 | .2059 | .2011 |
| ~~029~~ | ~~.3698~~ | ~~1.337E-03~~ | ~~.2034~~ | ~~.2048~~ | ~~.2021~~ |
| 030 | .4006 | 1.337E-03 | .2031 | .2048 | .2020 |
| 031 | .2001 | 1.337E-03 | .2027 | .2039 | .2023 |
| 032 | 1.223E-03 | 1.299E-03 | .2029 | .2033 | .2027 |
| 033 | -.1967 | 1.337E-03 | .2024 | .2025 | .2025 |
| 034 | -.3977 | 1.537E-03 | .2017 | .2027 | .2030 |
| 035 | 1.232E-03 | 1.308E-03 | .2035 | .2034 | .2034 |
| 036 | | | | | |

TABLE XXIII

RUN NO: 51877

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.2010 | 0.2019 | 0.2032 |
| 2 | -6.0000 | 0.0000 | 0.2014 | 0.2015 | 0.2036 |
| 3 | -5.0000 | 0.0000 | 0.2012 | 0.2015 | 0.2034 |
| 4 | -4.0000 | 0.0000 | 0.2014 | 0.2017 | 0.2041 |
| 5 | -3.0000 | 0.0000 | 0.2016 | 0.2016 | 0.2054 |
| 6 | -2.0000 | 0.0000 | 0.2019 | 0.2020 | 0.2034 |
| 7 | -1.0000 | 0.0000 | 0.2022 | 0.2023 | 0.2042 |
| 8 | 0.0000 | 0.0000 | 0.2026 | 0.2028 | 0.2031 |
| 9 | 1.0000 | 0.0000 | 0.2019 | 0.2029 | 0.2030 |
| 10 | 2.0000 | 0.0000 | 0.2019 | 0.2035 | 0.2020 |
| 11 | 3.0000 | 0.0000 | 0.2030 | 0.2042 | 0.2025 |
| 12 | 4.0000 | 0.0000 | 0.2021 | 0.2045 | 0.2022 |
| 13 | 5.0000 | 0.0000 | 0.2030 | 0.2052 | 0.2017 |
| 14 | 6.0000 | 0.0000 | 0.2032 | 0.2059 | 0.2024 |
| 15 | 7.0000 | 0.0000 | 0.2025 | 0.2062 | 0.2017 |
| 16 | 8.0000 | 0.0000 | 0.2028 | 0.2068 | 0.2005 |
| 17 | 9.0000 | 0.0000 | 0.2033 | 0.2077 | 0.2001 |
| 18 | 10.0000 | 0.0000 | 0.2026 | 0.2086 | 0.2007 |
| 19 | 11.0000 | 0.0000 | 0.2030 | 0.2095 | 0.1190 |
| 20 | 12.0000 | 0.0000 | 0.2035 | 0.2107 | 0.1977 |
| 21 | 13.0000 | 0.0000 | 0.2023 | 0.2113 | 0.1979 |
| 22 | 14.0000 | 0.0000 | 0.2028 | 0.2124 | 0.1964 |
| 23 | 6.0000 | 0.0000 | 0.2034 | 0.2059 | 0.2011 |
| 24 | 4.0000 | 0.0000 | 0.2031 | 0.2048 | 0.2020 |
| 25 | 2.0000 | 0.0000 | 0.2027 | 0.2039 | 0.2023 |
| 26 | 0.0000 | 0.0000 | 0.2029 | 0.2033 | 0.2027 |
| 27 | -2.0000 | 0.0000 | 0.2024 | 0.2025 | 0.2025 |
| 28 | -4.0000 | 0.0000 | 0.2017 | 0.2027 | 0.2030 |
| 29 | 0.0000 | 0.0000 | 0.2035 | 0.2034 | 0.2034 |

RUN # 51877 DATA IS STORED IN FILE# 9

TABLE XXIV

RUN 052602 ON 26 MAY 1977

PLATE PLUS FAIRING (WING OFF)

NOMINAL Q= 40 PSF

@

> SCAN

| #- | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 064 | .0122 | .0158 | .0079 | .0042 | .0012 |
| 065 | .0122 | 4.475 | -.0024 | -.0239 | .0418 |
| 066 | -5.971 | 4.467 | -.0026 | .0014 | .0218 |
| 067 | -4.982 | 4.441 | -.0030 | -.0004 | .0268 |
| 068 | -3.973 | 4.480 | -.0011 | -.0054 | .0311 |
| 069 | -2.979 | 4.396 | -.0018 | -.0098 | .0330 |
| 070 | -1.989 | 4.410 | -.0022 | -.0145 | .0360 |
| 071 | -.9666 | 4.353 | -.0037 | -.0194 | .0380 |
| 072 | .0122 | 4.438 | -.0045 | -.0251 | .0419 |
| 073 | .9912 | 4.373 | -.0042 | -.0290 | .0458 |
| 074 | 2.005 | 4.383 | -.0044 | -.0334 | .0465 |
| 075 | 2.994 | 4.441 | -.0031 | -.0379 | .0517 |
| 076 | 4.001 | 4.411 | -.0035 | -.0422 | .0544 |
| 077 | 4.999 | 4.409 | -.0046 | -.0456 | .0562 |
| 078 | 5.990 | 4.398 | -.0050 | -.0498 | .0593 |
| 079 | 6.984 | 4.383 | -.0062 | -.0539 | .0624 |
| 080 | 7.998 | 4.380 | -.0059 | -.0572 | .0641 |
| 081 | 9.001 | 4.322 | -.0064 | -.0607 | .0670 |
| 082 | 10.01 | 4.447 | -.0063 | -.0656 | .0719 |
| 083 | 11.00 | 4.408 | -.0073 | -.0690 | .0736 |
| 084 | 11.99 | 4.381 | -.0079 | -.0729 | .0771 |
| 085 | 12.99 | 4.357 | -.0078 | -.0764 | .0800 |
| 086 | 13.98 | 4.373 | -.0082 | -.0800 | .0[illegible] |
| 087 | 5.[illegible] | 4.402 | -.0042 | -.0493 | .0593 |
| 088 | 3.[illegible]34 | 4.398 | -.0034 | -.0411 | .0535 |
| 089 | 1.977 | 4.343 | -.0023 | -.0324 | .0469 |
| 090 | .0122 | 4.427 | -.0018 | -.0233 | .0419 |
| 091 | -1.988 | 4.344 | -.0017 | -.0132 | .0337 |
| 092 | -3.970 | 4.367 | -.0013 | -.0046 | .0279 |
| 093 | .0122 | 4.346 | -.0016 | -.0234 | .0412 |
| 094 | .0122 | .0203 | .0065 | .0020 | .0012 |

TABLE XXV

RUN NO: 52602

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0122 | 0.0158 | 0.0079 | 0.0042 | 0.0012 |
| 2 | -5.9710 | 4.4670 | -0.0026 | 0.0014 | 0.0218 |
| 3 | -4.9820 | 4.4410 | -0.0030 | -0.0004 | 0.0268 |
| 4 | -3.9730 | 4.4300 | -0.0011 | -0.0054 | 0.0311 |
| 5 | -2.9790 | 4.3960 | -0.0018 | -0.0098 | 0.0330 |
| 6 | -1.9890 | 4.4100 | -0.0022 | -0.0145 | 0.0360 |
| 7 | -0.9666 | 4.3530 | -0.0037 | -0.0194 | 0.0380 |
| 8 | 0.0122 | 4.4380 | -0.0045 | -0.0251 | 0.0419 |
| 9 | 0.9912 | 4.3730 | -0.0042 | -0.0290 | 0.0458 |
| 10 | 2.0050 | 4.3830 | -0.0044 | -0.0334 | 0.0465 |
| 11 | 2.9940 | 4.4410 | -0.0031 | -0.0379 | 0.0517 |
| 12 | 4.0010 | 4.4110 | -0.0035 | -0.0422 | 0.0544 |
| 13 | 4.9990 | 4.4090 | -0.0046 | -0.0456 | 0.0562 |
| 14 | 5.9900 | 4.3980 | -0.0050 | -0.0498 | 0.0593 |
| 15 | 6.9840 | 4.3830 | -0.0062 | -0.0539 | 0.0624 |
| 16 | 7.9980 | 4.3800 | -0.0059 | -0.0572 | 0.0641 |
| 17 | 9.0010 | 4.3220 | -0.0064 | -0.0607 | 0.0670 |
| 18 | 10.0100 | 4.4470 | -0.0063 | -0.0656 | 0.0719 |
| 19 | 11.0000 | 4.4080 | -0.0073 | -0.0690 | 0.0736 |
| 20 | 11.9900 | 4.3810 | -0.0079 | -0.0729 | 0.0771 |
| 21 | 12.9900 | 4.3570 | -0.0078 | -0.0764 | 0.0800 |
| 22 | 13.9800 | 4.3730 | -0.0082 | -0.0800 | 0.0835 |
| 23 | 5.9900 | 4.4020 | -0.0042 | -0.0493 | 0.0593 |
| 24 | 3.9840 | 4.3980 | -0.0034 | -0.0411 | 0.0535 |
| 25 | 1.9770 | 4.3430 | -0.0023 | -0.0324 | 0.0469 |
| 26 | 0.0122 | 4.4270 | -0.0018 | -0.0233 | 0.0419 |
| 27 | -1.9880 | 4.3440 | -0.0017 | -0.0132 | 0.0337 |
| 28 | -3.9700 | 4.3670 | -0.0013 | -0.0046 | 0.0279 |
| 29 | 0.0122 | 0.0203 | 0.0065 | 0.0020 | 0.0012 |

RUN # 52602   DATA IS STORED IN FILE# 5

TABLE XXVI

RUN 052603 ON 26 MAY 1977
PLATE PLUS FAIRING (WING OFF)
NOMINAL Q= 30 PSF

@
> SCAN

| # | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 095 | .0122 | .0187 | .0056 | .0012 | .0012 |
| 096 | .0122 | 3.249 | -.0006 | -.0184 | .0316 |
| 097 | -5.968 | 3.228 | -.0009 | .0035 | .0133 |
| 098 | -4.981 | 3.283 | -.0016 | .0012 | .0173 |
| 099 | -3.983 | 3.210 | -.0009 | -.0007 | .0202 |
| 100 | -2.979 | 3.263 | -.0002 | -.0059 | .0235 |
| 101 | -1.984 | 3.282 | -.0014 | -.0102 | .0253 |
| 102 | -.9658 | 3.236 | -.0010 | -.0146 | .0297 |
| 103 | .0122 | 3.287 | -.0004 | -.0186 | .0321 |
| 104 | .9927 | 3.325 | -.0005 | -.0242 | .0353 |
| 105 | 2.011 | 3.244 | .0005 | -.0275 | .0369 |
| 106 | 2.999 | 3.241 | -.0009 | -.0311 | .0401 |
| 107 | 3.988 | 3.198 | -.0010 | -.0353 | .0428 |
| 108 | 5.002 | 3.272 | -.0017 | -.0391 | .0467 |
| 109 | 5.994 | 3.246 | -.0015 | -.0427 | .0484 |
| 110 | 6.988 | 3.224 | -.0014 | -.0463 | .0513 |
| 111 | 8.002 | 3.235 | -.0026 | -.0507 | .0550 |
| 112 | 8.997 | 3.214 | -.0030 | -.0545 | .0578 |
| 113 | 10.01 | 3.281 | -.0033 | -.0585 | .0610 |
| 114 | 11.00 | 3.302 | -.0040 | -.0625 | .0632 |
| 115 | 12.00 | 3.234 | -.0045 | -.0661 | .0656 |
| 116 | 13.00 | 3.300 | -.0047 | -.0702 | .0689 |
| 117 | 13.98 | 3.209 | -.0059 | -.0734 | .070[illegible] |
| 118 | 5.994 | 3.236 | -.0015 | -.0435 | .0491 |
| 119 | 3.988 | 3.197 | -.0004 | -.0359 | .0425 |
| 120 | 1.982 | 3.245 | -.0004 | -.0278 | .0369 |
| 121 | .0122 | 3.252 | -.0009 | -.0185 | .0318 |
| 122 | -1.984 | 3.273 | .0002 | -.0104 | .0258 |
| 123 | -3.992 | 3.269 | .0004 | -.0011 | .0199 |
| 124 | .0122 | 3.204 | -.0012 | -.0186 | .0309 |
| 125 | .0122 | .0211 | .0054 | .0012 | .0012 |

TABLE XXVII

RUN NO: 52603

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0122 | 0.0187 | 0.0056 | 0.0012 | 0.0012 |
| 2 | -5.9680 | 3.2280 | -0.0009 | 0.0035 | 0.0133 |
| 3 | -4.9810 | 3.2830 | -0.0016 | 0.0012 | 0.0173 |
| 4 | -3.9830 | 3.2100 | -0.0009 | -0.0007 | 0.0202 |
| 5 | -2.9790 | 3.2630 | -0.0002 | -0.0059 | 0.0235 |
| 6 | -1.9840 | 3.2820 | -0.0014 | -0.0102 | 0.0253 |
| 7 | -0.9658 | 3.2360 | -0.0010 | -0.0146 | 0.0297 |
| 8 | 0.0122 | 3.2870 | -0.0004 | -0.0186 | 0.0321 |
| 9 | 0.9927 | 3.3250 | -0.0005 | -0.0242 | 0.0353 |
| 10 | 2.0110 | 3.2440 | 0.0005 | -0.0275 | 0.0369 |
| 11 | 2.9990 | 3.2410 | -0.0009 | -0.0311 | 0.0401 |
| 12 | 3.9880 | 3.1980 | -0.0010 | -0.0353 | 0.0428 |
| 13 | 5.0020 | 3.2720 | -0.0017 | -0.0391 | 0.0467 |
| 14 | 5.9940 | 3.2460 | -0.0015 | -0.0427 | 0.0484 |
| 15 | 6.9880 | 3.2240 | -0.0014 | -0.0463 | 0.0513 |
| 16 | 8.0020 | 3.2350 | -0.0026 | -0.0507 | 0.0550 |
| 17 | 8.9970 | 3.2140 | -0.0030 | -0.0545 | 0.0578 |
| 18 | 10.0100 | 3.2810 | -0.0033 | -0.0585 | 0.0610 |
| 19 | 11.0000 | 3.3020 | -0.0040 | -0.0625 | 0.0632 |
| 20 | 12.0000 | 3.2340 | -0.0045 | -0.0661 | 0.0656 |
| 21 | 13.0000 | 3.3000 | -0.0047 | -0.0702 | 0.0689 |
| 22 | 13.9800 | 3.2090 | -0.0059 | -0.0734 | 0.0703 |
| 23 | 5.9940 | 3.2360 | -0.0015 | -0.0435 | 0.0491 |
| 24 | 3.9880 | 3.1970 | -0.0004 | -0.0359 | 0.0425 |
| 25 | 1.9920 | 3.2450 | -0.0004 | -0.0278 | 0.0369 |
| 26 | 0.0122 | 3.2520 | -0.0009 | -0.0185 | 0.0318 |
| 27 | -1.9840 | 3.2730 | 0.0002 | -0.0104 | 0.0258 |
| 28 | -3.9920 | 3.2690 | 0.0004 | -0.0011 | 0.0199 |
| 29 | 0.0122 | 0.0211 | 0.0054 | 0.0012 | 0.0012 |

RUN # 52603   DATA IS STORED IN FILE# 6

TABLE XXVIII

RUN 052601 ON 26 MAY 1977
PLATE PLUS FAIRING (WING OFF)
NOMINAL Q= 20 PSF

@@
> SCAN

| # | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 033 | .0122 | .0124 | .0067 | .0024 | .0012 |
| 034 | .0122 | 2.175 | .0012 | -.0104 | .0199 |
| 035 | -5.974 | 2.176 | .0012 | .0115 | .0030 |
| 036 | -4.984 | 2.192 | .0013 | .0076 | .0050 |
| 037 | -3.995 | 2.207 | .0013 | .0031 | .0090 |
| 038 | -2.982 | 2.186 | .0012 | .0012 | .0112 |
| 039 | -1.992 | 2.175 | .0016 | .0000 | .0142 |
| 040 | -.9688 | 2.184 | .0014 | -.0048 | .0176 |
| 041 | .0122 | 2.187 | .0012 | -.0091 | .0206 |
| 042 | .9910 | 2.167 | .0016 | -.0123 | .0233 |
| 043 | 2.006 | 2.154 | .0015 | -.0168 | .0277 |
| 044 | 2.994 | 2.191 | .0019 | -.0199 | .0312 |
| 045 | 3.984 | 2.171 | .0029 | -.0238 | .0338 |
| 046 | 4.998 | 2.194 | .0021 | -.0277 | .0354 |
| 047 | 5.990 | 2.142 | .0016 | -.0308 | .0372 |
| 048 | 6.984 | 2.184 | .0018 | -.0349 | .0390 |
| 049 | 7.998 | 2.152 | .0021 | -.0378 | .0410 |
| 050 | 9.002 | 2.163 | .0013 | -.0415 | .0442 |
| 051 | 10.01 | 2.182 | .0016 | -.0452 | .0457 |
| 052 | 10.99 | 2.178 | .0014 | -.0484 | .0486 |
| 053 | 12.00 | 2.165 | .0014 | -.0517 | .0507 |
| 054 | 12.99 | 2.162 | .0013 | -.0556 | .0545 |
| 055 | 13.98 | 2.195 | .0012 | -.0585 | .0564 |
| 056 | 5.991 | 2.189 | .0015 | -.0311 | .0365 |
| 057 | 3.985 | 2.149 | .0022 | -.0231 | .0323 |
| 058 | 1.977 | 2.163 | .0020 | -.0157 | .0266 |
| 059 | .0122 | 2.174 | .0021 | -.0080 | .0202 |
| 060 | -1.989 | 2.213 | .0018 | .0011 | .0132 |
| 061 | -3.993 | 2.188 | .0017 | .0047 | .0079 |
| 062 | .0122 | 2.176 | .0018 | -.0081 | .0209 |
| 063 | .0122 | .0164 | .0076 | .0043 | .0012 |

TABLE XXIX

RUN NO: 52601

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0122 | 0.0124 | 0.0067 | 0.0024 | 0.0012 |
| 2 | -5.9740 | 2.1760 | 0.0012 | 0.0115 | 0.0030 |
| 3 | -4.9840 | 2.1920 | 0.0013 | 0.0076 | 0.0050 |
| 4 | -3.9950 | 2.2070 | 0.0013 | 0.0031 | 0.0090 |
| 5 | -2.9820 | 2.1860 | 0.0012 | 0.0012 | 0.0112 |
| 6 | -1.9920 | 2.1750 | 0.0016 | 0.0000 | 0.0142 |
| 7 | -0.9688 | 2.1840 | 0.0014 | -0.0048 | 0.0176 |
| 8 | 0.0122 | 2.1870 | 0.0012 | -0.0091 | 0.0206 |
| 9 | 0.9910 | 2.1670 | 0.0016 | -0.0123 | 0.0233 |
| 10 | 2.0060 | 2.1540 | 0.0015 | -0.0168 | 0.0277 |
| 11 | 2.9940 | 2.1910 | 0.0019 | -0.0199 | 0.0312 |
| 12 | 3.9840 | 2.1710 | 0.0029 | -0.0238 | 0.0338 |
| 13 | 4.9980 | 2.1940 | 0.0021 | -0.0277 | 0.0354 |
| 14 | 5.9900 | 2.1420 | 0.0016 | -0.0308 | 0.0372 |
| 15 | 6.9840 | 2.1840 | 0.0018 | -0.0349 | 0.0390 |
| 16 | 7.9980 | 2.1520 | 0.0021 | -0.0378 | 0.0410 |
| 17 | 9.0020 | 2.1630 | 0.0013 | -0.0415 | 0.0442 |
| 18 | 10.0100 | 2.1820 | 0.0016 | -0.0452 | 0.0457 |
| 19 | 10.9900 | 2.1780 | 0.0014 | -0.0484 | 0.0486 |
| 20 | 12.0000 | 2.1650 | 0.0014 | -0.0517 | 0.0507 |
| 21 | 12.9900 | 2.1620 | 0.0013 | -0.0556 | 0.0545 |
| 22 | 13.9800 | 2.1950 | 0.0012 | -0.0585 | 0.0564 |
| 23 | 5.9910 | 2.1890 | 0.0015 | -0.0311 | 0.0365 |
| 24 | 3.9850 | 2.1490 | 0.0022 | -0.0231 | 0.0323 |
| 25 | 1.9770 | 2.1630 | 0.0020 | -0.0157 | 0.0266 |
| 26 | 0.0122 | 2.1740 | 0.0021 | -0.0080 | 0.0202 |
| 27 | -1.9890 | 2.2130 | 0.0018 | 0.0011 | 0.0132 |
| 28 | -3.9930 | 2.1880 | 0.0017 | 0.0047 | 0.0079 |
| 29 | 0.0122 | 0.0164 | 0.0076 | 0.0043 | 0.0012 |

RUN # 52601    DATA IS STORED IN FILE# 4

TABLE XXX

1620 ON 26 MAY 1977
.. STATIC WEIGHT TARE, WIND-OFF..
.. PLATE PLUS FAIRING (WING-OFF)

> SCAN

| # | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 004 | .0122 | .0037 | .0014 | .0012 | .0011 |
| 005 | -5.993 | .0035 | .0012 | .0201 | -.0134 |
| 006 | -4.985 | .0048 | .0020 | .0181 | -.0117 |
| 007 | -3.979 | .0059 | .0017 | .0151 | -.0102 |
| 008 | -2.976 | .0064 | .0029 | .0114 | -.0076 |
| 009 | -1.992 | .0065 | .0036 | .0081 | -.0041 |
| 010 | -1.005 | .0066 | .0027 | .0048 | -.0029 |
| 011 | -.0047 | .0061 | .0038 | .0014 | .0010 |
| 012 | .9893 | .0060 | .0030 | .0012 | .0012 |
| 013 | 1.975 | .0062 | .0041 | -.0020 | .0014 |
| 014 | 2.983 | .0064 | .0039 | -.0061 | .0049 |
| 015 | 3.982 | .0067 | .0047 | -.0088 | .0060 |
| 016 | 4.998 | .0066 | .0030 | -.0133 | .0090 |
| 017 | 5.988 | .0072 | .0042 | -.0166 | .0112 |
| 018 | 6.984 | .0079 | .0045 | -.0183 | .0133 |
| 019 | 7.998 | .0079 | .0049 | -.0216 | .0150 |
| 020 | 8.991 | .0077 | .0052 | -.0247 | .0158 |
| 021 | 9.978 | .0083 | .0047 | -.0278 | .0190 |
| 022 | 11.00 | .0084 | .0050 | -.0304 | .0201 |
| 023 | 12.01 | .0092 | .0047 | -.0338 | .0220 |
| 024 | 12.99 | .0093 | .0049 | -.0366 | .0253 |
| 025 | 14.01 | .0094 | .0047 | -.0382 | .0264 |
| 026 | 5.986 | .0099 | .0062 | -.0138 | .0111 |
| 027 | 3.981 | .0100 | .0057 | -.0073 | .0062 |
| 028 | 1.975 | .0098 | .0059 | .0012 | .0025 |
| 029 | .0120 | .0101 | .0063 | .0037 | .0012 |
| 030 | -1.991 | .0100 | .0063 | .0106 | -.0034 |
| 031 | -3.977 | .0107 | .0059 | .0185 | -.0081 |
| 032 | .0122 | .0109 | .0076 | .0043 | .0012 |

TABLE XXXI

RUN NO: 52677

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0122 | 0.0037 | 0.0014 | 0.0012 | 0.0011 |
| 2 | -5.9930 | 0.0035 | 0.0012 | 0.0201 | -0.0134 |
| 3 | -4.9850 | 0.0048 | 0.0020 | 0.0181 | -0.0117 |
| 4 | -3.9790 | 0.0059 | 0.0017 | 0.0151 | -0.0102 |
| 5 | -2.9760 | 0.0064 | 0.0029 | 0.0114 | -0.0076 |
| 6 | -1.9920 | 0.0065 | 0.0036 | 0.0081 | -0.0041 |
| 7 | -1.0050 | 0.0066 | 0.0027 | 0.0048 | -0.0029 |
| 8 | -0.0047 | 0.0061 | 0.0038 | 0.0014 | 0.0010 |
| 9 | 0.9893 | 0.0060 | 0.0030 | 0.0012 | 0.0012 |
| 10 | 1.9750 | 0.0062 | 0.0041 | -0.0020 | 0.0014 |
| 11 | 2.9830 | 0.0064 | 0.0039 | -0.0061 | 0.0049 |
| 12 | 3.9820 | 0.0067 | 0.0047 | -0.0088 | 0.0060 |
| 13 | 4.9980 | 0.0066 | 0.0030 | -0.0133 | 0.0090 |
| 14 | 5.9880 | 0.0072 | 0.0042 | -0.0166 | 0.0112 |
| 15 | 6.9840 | 0.0079 | 0.0045 | -0.0183 | 0.0133 |
| 16 | 7.9980 | 0.0079 | 0.0049 | -0.0216 | 0.0150 |
| 17 | 8.9910 | 0.0077 | 0.0052 | -0.0247 | 0.0158 |
| 18 | 9.9780 | 0.0083 | 0.0047 | -0.0278 | 0.0190 |
| 19 | 11.0000 | 0.0084 | 0.0050 | -0.0304 | 0.0201 |
| 20 | 12.0100 | 0.0092 | 0.0047 | -0.0338 | 0.0220 |
| 21 | 12.9900 | 0.0093 | 0.0049 | -0.0366 | 0.0253 |
| 22 | 14.0100 | 0.0094 | 0.0047 | -0.0382 | 0.0264 |
| 23 | 5.9860 | 0.0099 | 0.0062 | -0.0138 | 0.0111 |
| 24 | 3.9810 | 0.0100 | 0.0057 | -0.0073 | 0.0062 |
| 25 | 1.9750 | 0.0098 | 0.0059 | 0.0012 | 0.0025 |
| 26 | 0.0120 | 0.0101 | 0.0063 | 0.0037 | 0.0012 |
| 27 | -1.9910 | 0.0100 | 0.0063 | 0.0106 | -0.0034 |
| 28 | -3.9770 | 0.0107 | 0.0059 | 0.0185 | -0.0081 |
| 29 | 0.0122 | 0.0109 | 0.0076 | 0.0043 | 0.0012 |

RUN # 52677 DATA IS STORED IN FILE# 3

XXXII

RUN 052703 ON 27 MAY 1977
PLATE PLUS FAIRING AND WING
NOMINAL Q= 40 PSF

SC0
> SCNA

| # | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 092 | .0122 | .2229 | .0052 | .0063 | .0019 |
| 093 | .0122 | 41.02 | .0066 | -.0462 | .0800 |
| 094 | -5.948 | 39.55 | .3015 | .0254 | .0649 |
| 095 | -4.962 | 39.89 | .2561 | .0120 | .0615 |
| 096 | -3.962 | 39.56 | .2026 | .0005 | .0620 |
| 097 | -2.956 | 40.23 | .1487 | -.0134 | .0656 |
| 098 | -1.960 | 40.13 | .1031 | -.0234 | .0662 |
| 099 | -.9533 | 39.97 | .0552 | -.0353 | .0723 |
| 100 | .0122 | 40.69 | .0079 | -.0455 | .0798 |
| 101 | 1.015 | 40.79 | -.0392 | -.0530 | .0839 |
| 102 | 2.002 | 40.86 | -.0925 | -.0573 | .0905 |
| 103 | 3.022 | 40.82 | -.1424 | -.0607 | .0978 |
| 104 | 4.010 | 40.68 | -.1872 | -.0635 | .1075 |
| 105 | 5.026 | 40.96 | -.2393 | -.0645 | .1175 |
| 106 | 6.016 | 41.27 | -.2892 | -.0658 | .1320 |
| 107 | 7.010 | 40.85 | -.3339 | -.0704 | .1533 |
| 108 | 8.022 | 40.98 | -.3756 | -.0858 | .1891 |
| 109 | 9.013 | 41.47 | -.4239 | -.1228 | .2630 |
| 110 | 10.03 | 40.86 | -.4517 | -.1800 | .3664 |
| 111 | 11.02 | 40.88 | -.4762 | -.2431 | .4788 |
| 112 | 12.02 | 40.59 | -.4874 | -.3096 | .5928 |
| 113 | 13.01 | 40.00 | -.4844 | -.3767 | .7027 |
| 114 | 14.01 | 40.23 | -.4834 | -.4371 | .8013 |
| 115 | 6.018 | 41.15 | -.2862 | -.0670 | .1341 |
| 116 | 4.011 | 40.56 | -.1875 | -.0629 | .1084 |
| 117 | 2.017 | 41.01 | -.0894 | -.0573 | .0920 |
| 118 | .0122 | 41.27 | .0119 | -.0449 | .0803 |
| 119 | -1.961 | 40.10 | .1073 | -.0221 | .0674 |
| 120 | -3.978 | 40.59 | .2092 | .0006 | .0636 |
| 121 | .0122 | 40.17 | .0089 | -.0429 | .0792 |
| 122 | .0122 | .2811 | .0012 | .0057 | .0012 |

AD-A047 204 NAVAL POSTGRADUATE SCHOOL MONTEREY CALIF F/G 14/2
DESIGN STUDY OF A CENTERPLATE MOUNT FOR WIND TUNNEL MODELS.(U)
JUN 77 R W RUSSELL

UNCLASSIFIED NL

2 OF 2
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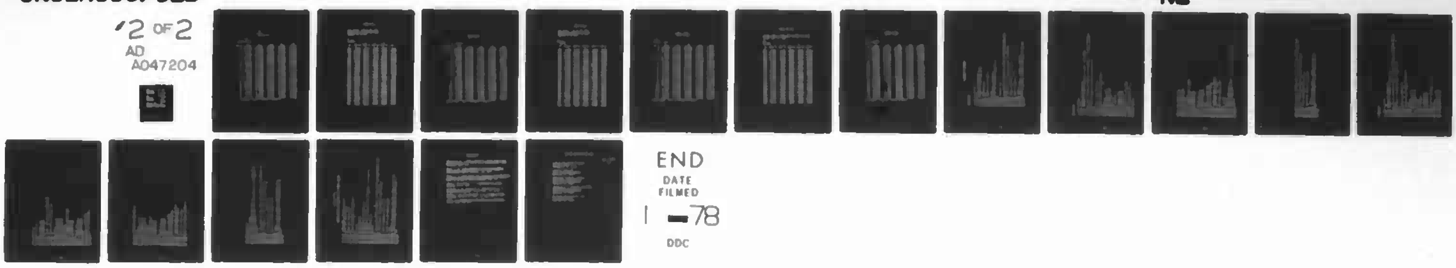
A047204



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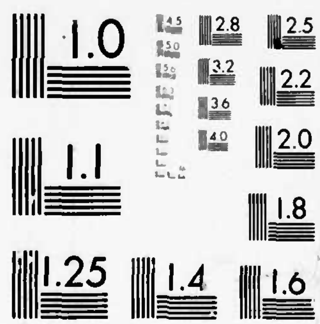
047 2




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE XXXIII

RUN NO: 52703

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0122 | 0.2229 | 0.0052 | 0.0063 | 0.0019 |
| 2 | -5.9480 | 39.5500 | 0.3015 | 0.0254 | 0.0649 |
| 3 | -4.9620 | 39.8900 | 0.2561 | 0.0120 | 0.0615 |
| 4 | -3.9620 | 39.5600 | 0.2026 | 0.0005 | 0.0620 |
| 5 | -2.9560 | 40.2300 | 0.1487 | -0.0134 | 0.0656 |
| 6 | -1.9600 | 40.1300 | 0.1031 | -0.0234 | 0.0662 |
| 7 | -0.9533 | 39.9700 | 0.0552 | -0.0353 | 0.0723 |
| 8 | 0.0122 | 40.6900 | 0.0079 | -0.0455 | 0.0798 |
| 9 | 1.0150 | 40.7900 | -0.0392 | -0.0530 | 0.0839 |
| 10 | 2.0020 | 40.8600 | -0.0925 | -0.0573 | 0.0905 |
| 11 | 3.0220 | 40.8200 | -0.1424 | -0.0607 | 0.0978 |
| 12 | 4.0100 | 40.6800 | -0.1872 | -0.0635 | 0.1075 |
| 13 | 5.0260 | 40.9600 | -0.2393 | -0.0645 | 0.1175 |
| 14 | 6.0160 | 41.2700 | -0.2892 | -0.0658 | 0.1320 |
| 15 | 7.0100 | 40.8500 | -0.3339 | -0.0704 | 0.1533 |
| 16 | 8.0220 | 40.9800 | -0.3756 | -0.0858 | 0.1891 |
| 17 | 9.0130 | 41.4700 | -0.4239 | -0.1228 | 0.2630 |
| 18 | 10.0300 | 40.8600 | -0.4517 | -0.1800 | 0.3664 |
| 19 | 11.0200 | 40.8800 | -0.4762 | -0.2431 | 0.4788 |
| 20 | 12.0200 | 40.5900 | -0.4874 | -0.3096 | 0.5928 |
| 21 | 13.0100 | 40.0000 | -0.4844 | -0.3767 | 0.7027 |
| 22 | 14.0100 | 40.2300 | -0.4834 | -0.4371 | 0.8013 |
| 23 | 6.0180 | 41.1500 | -0.2862 | -0.0670 | 0.1341 |
| 24 | 4.0110 | 40.5600 | -0.1875 | -0.0629 | 0.1084 |
| 25 | 2.0170 | 41.0100 | -0.0894 | -0.0573 | 0.0920 |
| 26 | 0.0122 | 41.2700 | 0.0119 | -0.0449 | 0.0803 |
| 27 | -1.9610 | 40.1000 | 0.1073 | -0.0221 | 0.0674 |
| 28 | -3.9760 | 40.5900 | 0.2092 | 0.0006 | 0.0636 |
| 29 | 0.0122 | 0.2811 | 0.0012 | 0.0057 | 0.0012 |

RUN # 52703 DATA IS STORED IN FILE# 10

TABLE XXXIV

RUN 052702 ON 27 MAY 1977
PLATE PLUS FAIRING AND WING
NOMINAL Q= 30 PSF

@
> SCAN

| # | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 061 | .0122 | .1835 | .0046 | .0049 | .0012 |
| 062 | .0122 | 30.97 | .0032 | -.0343 | .0608 |
| 063 | -5.948 | 30.15 | .2277 | .0270 | .0449 |
| 064 | -4.962 | 30.89 | .1965 | .0132 | .0468 |
| 065 | -3.945 | 30.30 | .1549 | .0036 | .0442 |
| 066 | -2.955 | 30.68 | .1170 | -.0037 | .0455 |
| 067 | -1.960 | 30.39 | .0758 | -.0151 | .0504 |
| 068 | -.9538 | 30.53 | .0419 | -.0246 | .0548 |
| 069 | .0122 | 30.73 | .0040 | -.0343 | .0612 |
| 070 | .9997 | 30.59 | -.0322 | -.0402 | .0664 |
| 071 | 2.005 | 30.60 | -.0734 | -.0451 | .0718 |
| 072 | 3.023 | 30.75 | -.1106 | -.0516 | .0768 |
| 073 | 4.009 | 30.76 | -.1475 | -.0540 | .0843 |
| 074 | 5.027 | 30.87 | -.1829 | -.0569 | .0945 |
| 075 | 6.017 | 30.97 | -.2232 | -.0573 | .1055 |
| 076 | 7.008 | 30.78 | -.2520 | -.0639 | .1252 |
| 077 | 8.022 | 30.75 | -.2893 | -.0808 | .1600 |
| 078 | 9.012 | 30.62 | -.3134 | -.1083 | .2096 |
| 079 | 10.02 | 30.58 | -.3399 | -.1531 | .2906 |
| 080 | 11.02 | 30.55 | -.3563 | -.2017 | .3754 |
| 081 | 12.02 | 30.57 | -.3670 | -.2554 | .4665 |
| 082 | 13.01 | 30.12 | -.3631 | -.3036 | .5426 |
| 083 | 14.01 | 30.45 | -.3683 | -.3531 | .6267 |
| 084 | 6.017 | 30.54 | -.2189 | -.0563 | .1059 |
| 085 | 4.010 | 30.90 | -.1449 | -.0522 | .0851 |
| 086 | 2.005 | 30.40 | -.0647 | -.0458 | .0726 |
| 087 | .0122 | 30.75 | .0052 | -.0335 | .0619 |
| 088 | -1.962 | 30.73 | .0821 | -.0144 | .0513 |
| 089 | -3.979 | 30.36 | .1579 | .0044 | .0436 |
| 090 | .0122 | 30.11 | .0064 | -.0326 | .0604 |
| 091 | .0122 | .2240 | .0038 | .0054 | .0014 |

TABLE XXXV

RUN NO: 52702

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0122 | 0.1835 | 0.0046 | 0.0049 | 0.0012 |
| 2 | -5.9480 | 30.1500 | 0.2277 | 0.0270 | 0.0449 |
| 3 | -4.9620 | 30.8900 | 0.1965 | 0.0132 | 0.0468 |
| 4 | -3.9450 | 30.3000 | 0.1549 | 0.0036 | 0.0442 |
| 5 | -2.9550 | 30.6800 | 0.1170 | -0.0037 | 0.0455 |
| 6 | -1.9600 | 30.3900 | 0.0758 | -0.0151 | 0.0504 |
| 7 | -0.9538 | 30.5300 | 0.0419 | -0.0246 | 0.0548 |
| 8 | 0.0122 | 30.7300 | 0.0040 | -0.0343 | 0.0612 |
| 9 | 0.9997 | 30.5900 | -0.0322 | -0.0402 | 0.0664 |
| 10 | 2.0050 | 30.6000 | -0.0734 | -0.0451 | 0.0718 |
| 11 | 3.0230 | 30.7500 | -0.1106 | -0.0516 | 0.0768 |
| 12 | 4.0090 | 30.7600 | -0.1475 | -0.0540 | 0.0843 |
| 13 | 5.0270 | 30.8700 | -0.1829 | -0.0569 | 0.0945 |
| 14 | 6.0170 | 30.9700 | -0.2232 | -0.0573 | 0.1055 |
| 15 | 7.0080 | 30.7800 | -0.2520 | -0.0639 | 0.1252 |
| 16 | 8.0220 | 30.7500 | -0.2893 | -0.0808 | 0.1600 |
| 17 | 9.0120 | 30,6200 | -0.3134 | -0.1083 | 0.2096 |
| 18 | 10.0200 | 30.5800 | -0.3399 | -0.1531 | 0.2906 |
| 19 | 11.0200 | 30.5500 | -0.3563 | -0.2017 | 0.3754 |
| 20 | 12.0200 | 30.5700 | -0.3670 | -0.2554 | 0.4665 |
| 21 | 13.0100 | 30.1200 | -0.3631 | -0.3036 | 0.5426 |
| 22 | 14.0100 | 30.4500 | -0.3683 | -0.3531 | 0.6267 |
| 23 | 6.0170 | 30.5400 | -0.2189 | -0.0563 | 0.1059 |
| 24 | 4.0100 | 30.9000 | -0.1449 | -0.0522 | 0.0851 |
| 25 | 2.0050 | 30.4000 | -0.0647 | -0.0458 | 0.0726 |
| 26 | 0.0122 | 30.7500 | 0.0052 | -0.0335 | 0.0619 |
| 27 | -1.9620 | 30.7300 | 0.0821 | -0.0144 | 0.0513 |
| 28 | -3.9790 | 30.3600 | 0.1579 | 0.0044 | 0.0436 |
| 29 | 0.0122 | 0.2240 | 0.0038 | 0.0054 | 0.0014 |

RUN # 52702   DATA IS STORED IN FILE# 9

TABLE XXXVI

RUN 052701 · ON 27 MAY 1977
PLATE PLUS FAIRING AND WING
NOMINAL Q= 20 PSF

> SCAN

| # | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 030 | .0122 | .1477 | .0041 | .0038 | .0024 |
| 031 | .0123 | 20.24 | .0118 | -.0198 | .0430 |
| 032 | -5.961 | 20.21 | .1608 | .0324 | .0246 |
| 033 | -4.963 | 20.04 | .1348 | .0211 | .0251 |
| 034 | -3.967 | 19.91 | .1118 | .0129 | .0252 |
| 035 | -2.956 | 19.63 | .0833 | .0031 | .0285 |
| 036 | -1.961 | 20.04 | .0585 | -.0024 | .0315 |
| 037 | -.9538 | 19.91 | .0354 | -.0115 | .0367 |
| 038 | .0122 | 20.10 | .0089 | -.0205 | .0422 |
| 039 | 1.015 | 19.88 | -.0149 | -.0286 | .0465 |
| 040 | 2.002 | 20.13 | -.0407 | -.0342 | .0519 |
| 041 | 3.021 | 20.07 | -.0651 | -.0389 | .0584 |
| 042 | 4.009 | 20.15 | -.0857 | -.0442 | .0655 |
| 043 | 5.025 | 20.02 | -.1150 | -.0461 | .0713 |
| 044 | 6.017 | 20.20 | -.1395 | -.0503 | .0810 |
| 045 | 7.032 | 19.97 | -.1621 | -.0550 | .0927 |
| 046 | 8.021 | 20.15 | -.1814 | -.0675 | .1160 |
| 047 | 9.012 | 20.05 | -.2031 | -.0906 | .1575 |
| 048 | 10.01 | 19.72 | -.2152 | -.1229 | .2103 |
| 049 | 11.02 | 19.92 | -.2296 | -.1559 | .2678 |
| 050 | 12.02 | 19.74 | -.2334 | -.1913 | .3256 |
| 051 | 13.01 | 19.83 | -.2365 | -.2282 | .3848 |
| 052 | 14.01 | 19.63 | -.2323 | -.2573 | .4277 |
| 053 | 6.017 | 20.03 | -.1401 | -.0477 | .0787 |
| 054 | 4.010 | 20.31 | -.0886 | -.0422 | .0654 |
| 055 | 2.002 | 19.82 | -.0391 | -.0323 | .0509 |
| 056 | .0122 | 20.30 | .0068 | -.0197 | .0425 |
| 057 | -1.961 | 20.10 | .0669 | -.0005 | .0301 |
| 058 | -3.979 | 19.93 | .1154 | .0138 | .0230 |
| 059 | .0122 | 20.08 | .0103 | -.0200 | .0431 |
| 060 | .0122 | .1900 | .0043 | .0048 | .0022 |

## TABLE XXXVII

RUN NO: 52701

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0122 | 0.1477 | 0.0041 | 0.0038 | 0.0024 |
| 2 | -5.9610 | 20.2100 | 0.1608 | 0.0324 | 0.0246 |
| 3 | -4.9630 | 20.0400 | 0.1348 | 0.0211 | 0.0251 |
| 4 | -3.9670 | 19.9100 | 0.1118 | 0.0129 | 0.0252 |
| 5 | -2.9560 | 19.6300 | 0.0833 | 0.0031 | 0.0285 |
| 6 | -1.9610 | 20.0400 | 0.0585 | -0.0024 | 0.0315 |
| 7 | -0.9538 | 19.9100 | 0.0354 | -0.0115 | 0.0367 |
| 8 | 0.0122 | 20.1000 | 0.0089 | -0.0205 | 0.0422 |
| 9 | 1.0156 | 19.9800 | -0.0149 | -0.0286 | 0.0465 |
| 10 | 2.0020 | 20.1300 | -0.0407 | -0.0342 | 0.0519 |
| 11 | 3.0210 | 20.0700 | -0.0651 | -0.0389 | 0.0584 |
| 12 | 4.0090 | 20.1500 | -0.0857 | -0.0442 | 0.0655 |
| 13 | 5.0250 | 20.0200 | -0.1150 | -0.0461 | 0.0713 |
| 14 | 6.0170 | 20.2000 | -0.1395 | -0.0503 | 0.0810 |
| 15 | 7.0320 | 19.9700 | -0.1621 | -0.0550 | 0.0927 |
| 16 | 8.0210 | 20.1500 | -0.1814 | -0.0675 | 0.1160 |
| 17 | 9.0120 | 20.0500 | -0.2031 | -0.0906 | 0.1575 |
| 18 | 10.0100 | 19.7200 | -0.2152 | -0.1229 | 0.2103 |
| 19 | 11.0200 | 19.9200 | -0.2296 | -0.1559 | 0.2678 |
| 20 | 12.0200 | 19.7400 | -0.2334 | -0.1913 | 0.3256 |
| 21 | 13.0100 | 19.8300 | -0.2365 | -0.2282 | 0.3848 |
| 22 | 14.0100 | 19.6300 | -0.2323 | -0.2573 | 0.4277 |
| 23 | 6.0170 | 20.0300 | -0.1401 | -0.0477 | 0.0787 |
| 24 | 4.0100 | 20.3100 | -0.0886 | -0.0422 | 0.0654 |
| 25 | 2.0020 | 19.8200 | -0.0391 | -0.0323 | 0.0509 |
| 26 | 0.0122 | 20.3000 | 0.0068 | -0.0197 | 0.0425 |
| 27 | -1.9610 | 20.1000 | 0.0669 | -0.0005 | 0.0301 |
| 28 | -3.9790 | 19.9300 | 0.1154 | 0.0138 | 0.0230 |
| 29 | 0.0122 | 0.1900 | 0.0043 | 0.0048 | 0.0022 |

RUN # 52701 DATA IS STORED IN FILE# 8

TABLE XXXVIII

WEIGHT TARE...PLATE PLUS FAIRING AND WING
27 MAY 1977 AT 1620

W0
> SCAN

| # | CH. 0 | CH. 1 | CH. 2 | CH. 3 | CH. 4 |
|---|---|---|---|---|---|
| 001 | .0124 | .1410 | .0036 | .0025 | .0038 |
| 002 | -5.949 | .1404 | .0038 | .0408 | -.0182 |
| 003 | -4.959 | .1383 | .0033 | .0346 | -.0140 |
| 004 | -3.943 | .1418 | .0035 | .0278 | -.0099 |
| 005 | -2.951 | .1419 | .0033 | .0212 | -.0056 |
| 006 | -1.961 | .1438 | .0047 | .0160 | .0006 |
| 007 | -.9545 | .1456 | .0042 | .0102 | .0012 |
| 008 | .0122 | .1435 | .0049 | .0038 | .0039 |
| 009 | 1.016 | .1436 | .0052 | .0012 | .0062 |
| 010 | 2.003 | .1457 | .0047 | -.0043 | .0111 |
| 011 | 3.022 | .1456 | .0046 | -.0103 | .0165 |
| 012 | 4.010 | .1467 | .0045 | -.0171 | .0208 |
| 013 | 4.996 | .1446 | .0046 | -.0228 | .0245 |
| 014 | 6.017 | .1411 | .0041 | -.0287 | .0285 |
| 015 | 7.008 | .1443 | .0039 | -.0352 | .0316 |
| 016 | 8.022 | .1433 | .0045 | -.0402 | .0364 |
| 017 | 9.028 | .1434 | .0040 | -.0464 | .0391 |
| 018 | 10.03 | .1456 | .0044 | -.0517 | .0436 |
| 019 | 11.02 | .1476 | .0042 | -.0574 | .0476 |
| 020 | 12.01 | .1492 | .0046 | -.0627 | .0516 |
| 021 | 13.00 | .1485 | .0042 | -.0682 | .0540 |
| 022 | 14.01 | .1496 | .0044 | -.0736 | .0578 |
| 023 | 6.017 | .1483 | .0041 | -.0281 | .0281 |
| 024 | 4.009 | .1484 | .0053 | -.0166 | .0205 |
| 025 | 2.002 | .1501 | .0045 | -.0035 | .0111 |
| 026 | .0122 | .1488 | .0057 | .0045 | .0015 |
| 027 | -1.960 | .1543 | .0055 | .0165 | -.0012 |
| 028 | -3.977 | .1552 | .0048 | .0298 | -.0108 |
| 029 | .0122 | .1497 | .0050 | .0045 | .0024 |

TABLE XXXIX

RUN NO: 52777

| ROW # | CH0 | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|---|
| 1 | 0.0124 | 0.1410 | 0.0036 | 0.0025 | 0.0038 |
| 2 | -5.9490 | 0.1404 | 0.0038 | 0.0408 | -0.0182 |
| 3 | -4.9590 | 0.1383 | 0.0033 | 0.0346 | -0.0140 |
| 4 | -3.9430 | 0.1418 | 0.0035 | 0.0278 | -0.0099 |
| 5 | -2.9510 | 0.1419 | 0.0033 | 0.0212 | -0.0056 |
| 6 | -1.9610 | 0.1438 | 0.0047 | 0.0160 | 0.0006 |
| 7 | -0.9545 | 0.1456 | 0.0042 | 0.0102 | 0.0012 |
| 8 | 0.0122 | 0.1435 | 0.0049 | 0.0038 | 0.0039 |
| 9 | 1.0160 | 0.1436 | 0.0052 | 0.0012 | 0.0062 |
| 10 | 2.0030 | 0.1457 | 0.0047 | -0.0043 | 0.0111 |
| 11 | 3.0220 | 0.1456 | 0.0046 | -0.0103 | 0.0165 |
| 12 | 4.0100 | 0.1467 | 0.0045 | -0.0171 | 0.0208 |
| 13 | 4.9960 | 0.1446 | 0.0046 | -0.0228 | 0.0245 |
| 14 | 6.0170 | 0.1411 | 0.0041 | -0.0287 | 0.0285 |
| 15 | 7.0080 | 0.1443 | 0.0039 | -0.0352 | 0.0316 |
| 16 | 8.0220 | 0.1433 | 0.0045 | -0.0402 | 0.0364 |
| 17 | 9.0280 | 0.1434 | 0.0040 | -0.0464 | 0.0391 |
| 18 | 10.0300 | 0.1456 | 0.0044 | -0.0517 | 0.0436 |
| 19 | 11.0200 | 0.1476 | 0.0042 | -0.0574 | 0.0476 |
| 20 | 12.0100 | 0.1492 | 0.0046 | -0.0627 | 0.0516 |
| 21 | 13.0000 | 0.1485 | 0.0042 | -0.0682 | 0.0540 |
| 22 | 14.0100 | 0.1496 | 0.0044 | -0.0736 | 0.0578 |
| 23 | 6.0170 | 0.1483 | 0.0041 | -0.0281 | 0.0281 |
| 24 | 4.0090 | 0.1484 | 0.0053 | -0.0166 | 0.0205 |
| 25 | 2.0020 | 0.1501 | 0.0045 | -0.0035 | 0.0111 |
| 26 | 0.0122 | 0.1488 | 0.0057 | 0.0045 | 0.0015 |
| 27 | -1.9600 | 0.1543 | 0.0055 | 0.0165 | -0.0012 |
| 28 | -3.9770 | 0.1552 | 0.0048 | 0.0298 | -0.0108 |
| 29 | 0.0122 | 0.1497 | 0.0050 | 0.0045 | 0.0024 |

RUN # 52777 DATA IS STORED IN FILE# 7

## COMPUTER PROGRAMS

### Program A

```
10 COM R1,D[40,5]
11 REM.......
12 REM "TUNNEL DATA PROCESSING"
13 REM "PROGRAM TO STORE DATA ON TAPE"
14 REM ......
20 DISP "ENTER RUN #";
30 INPUT R1
40 DISP "ENTER # OF DATA ROWS";
50 INPUT J
60 FOR N=1 TO J
70 DISP "ENTER DATA ROW";N;"";
80 INPUT D[N,1],D[N,2],D[N,3],D[N,4],D[N,5]
90 NEXT N
91 PRINT
92 PRINT "RUN NO: "R1
93 PRINT
95 PRINT "ROW #"TAB10"CH0"TAB20"CH1"TAB30"CH2"TAB40"CH3"TAB50"CH4"
100 FOR N=1 TO J
110 WRITE (15,300)N,D[N,1],D[N,2],D[N,3],D[N,4],D[N,5]
115 NEXT N
120 DISP "VERIFY DATA, PRESS (CONT-EXEC) ";
125 STOP
130 DISP "INPUT STORAGE FILE #";
140 INPUT Z
150 STORE  DATA Z
155 PRINT "RUN #"R1"DATA IS STORED IN FILE#"Z""
300 FORMAT 2X,F3.0,2X,F7.4,3X,F7.4,3X,F7.4,3X,F7.4,3X,F7.4
500 END
```

Program B

```
1 COM R1,D[40,5]
10 REM .....
11 REM "TUNNEL DATA PROCESSING"
12 REM "PROGRAM TO GENERATE CL,CD,CM-C/4 FOR 3 STRUT MOUNT"
13 REM .....
20 DIM A[3,3],L[3,1],X[40,5],T[40,5],C[40,5],U$[80],Y[3,1],V[40,5],W[40,5]
30 MAT READ A
40 DATA -96.154,0,0,0,17.5,25.575,0,-69.065,-66.07
50 C1=0.5
60 S1=1.5
61 DISP "ENTER # OF DATA ROWS";
62 INPUT J
70 DISP "ENTER WIND OFF WT TARE FILE #";
80 INPUT G
90 LOAD  DATA G
120 K1=(D[1,3]+D[J,3])/2
130 K2=(D[1,4]+D[J,4])/2
140 K3=(D[1,5]+D[J,5])/2
150 FOR N=2 TO J-1
160 FOR K=1 TO 2
170 T[N-1,K]=D[N,K]
180 NEXT K
190 T[N-1,3]=D[N,3]-K1
200 T[N-1,4]=D[N,4]-K2
210 T[N-1,5]=D[N,5]-K3
220 NEXT N
237 DISP "ENTER Q CAL FOR RUN";
238 INPUT Z
239 DISP "ENTER RUN FILE #";
240 INPUT G
250 LOAD  DATA G
```

```
260 K1=(D[1,2]+D[J,2])/2
270 K2=(D[1,3]+D[J,3])/2
280 K3=(D[1,4]+D[J,4])/2
290 K4=(D[1,5]+D[J,5])/2
300 FOR N=2 TO J-1
310 X[N-1,1]=D[N,1]
320 X[N-1,2]=(D[N,2]-K1)*Z/0.1084
330 X[N-1,3]=D[N,3]-K2
340 X[N-1,4]=D[N,4]-K3
350 X[N-1,5]=D[N,5]-K4
360 NEXT N
370 FOR N=1 TO J-2
380 L[1,1]=X[N,3]-T[N,3]
390 L[2,1]=X[N,4]-T[N,4]
400 L[3,1]=X[N,5]-T[N,5]
410 MAT Y=A*L
420 X[N,3]=Y[1,1]/(X[N,2]*S1)
430 X[N,4]=Y[2,1]/(X[N,2]*S1)
440 X[N,5]=Y[3,1]/(X[N,2]*S1*C1)
450 NEXT N
870 PRINT "CORRECTED DATA OF RUN #"R1
880 DISP "INPUT WALL CORR'N-DRAG";
890 INPUT B
900 DISP "ENTER WALL CORR'N-ADA";
910 INPUT F
920 FOR N=1 TO J-2
930 A1=X[N,1]/57.3
940 D[N,3]=X[N,3]
950 D[N,4]=X[N,4]+B*D[N,3]↑2
960 D[N,5]=X[N,5]+(D[N,3]*0.008333*SIN(A1)-D[N,4]*0.008333*COS(A1))/C1
970 D[N,1]=X[N,1]+F*D[N,3]
980 D[N,2]=X[N,2]
990 NEXT N
```

```
1000 PRINT "ROW #"TAB8"AOA(DEG)"TAB18"Q(PSF)"TAB30"CL"TAB40"CD"TAB48"CM-C/4"
1010 FOR N=1 TO J-2
1020 WRITE (15,1300)N,D[N,1],D[N,2],D[N,3],D[N,4],D[N,5]
1030 NEXT N
1040 DISP "CHECK DATA,PRESS (CONT-EXEC)";
1050 STOP
1060 DISP "ENTER FILE # FOR REDUCED DATA";
1070 INPUT Z
1080 STORE  DATA Z
1090 PRINT "RUN #"R1"REDUCED DATA IS STORED IN FILE #"Z" "
1300 FORMAT 2X,F3.0,1X,F8.4,2X,F8.4,3X,F7.4,3X,F7.4,3X,F7.4
1400 GOTO 237
1410 END
```

## Program C

```
1 COM R1,D[40,5]
10 REM .....
11 REM "TUNNEL DATA PROCESSING"
12 REM "PROGRAM TO GENERATE CL,CD,CM-C/4"
13 REM .....
20 DIM A[3,3],L[3,1],X[40,5],T[40,5],C[40,5],U$[80],Y[3,1],V[40,5],W[40,5]
30 MAT READ A
40 DATA -96.154,0,0,0,17.5,25.575,0,-89.065,-66.07
50 C1=0.5
60 S1=1.5
61 DISP "ENTER # OF DATA ROWS";
62 INPUT J
70 DISP "ENTER WD/WG OFF TARE DATA FILE #";
80 INPUT G
90 LOAD  DATA G
120 K1=(D[1,3]+D[J,3])/2
130 K2=(D[1,4]+D[J,4])/2
140 K3=(D[1,5]+D[J,5])/2
150 FOR N=2 TO J-1
160 FOR K=1 TO 2
170 T[N-1,K]=D[N,K]
180 NEXT K
190 T[N-1,3]=D[N,3]-K1
200 T[N-1,4]=D[N,4]-K2
210 T[N-1,5]=D[N,5]-K3
220 NEXT N
221 DISP "ENTER WD OFF/WG ON TARE FILE #";
222 INPUT G
223 LOAD  DATA G
224 K1=(D[1,3]+D[J,3])/2
225 K2=(D[1,4]+D[J,4])/2
226 K3=(D[1,5]+D[J,5])/2
```

```
227 FOR N=2 TO J-1
228 FOR K=1 TO 2
229 V[N-1,K]=D[N,K]
230 NEXT K
231 V[N-1,3]=D[N,3]-K1
232 V[N-1,4]=D[N,4]-K2
233 V[N-1,5]=D[N,5]-K3
234 NEXT N
237 DISP "ENTER Q CAL OF 05-25-77 FOR RUN";
238 INPUT Z
239 DISP "ENTER WING OFF RUN FILE #";
240 INPUT G
250 LOAD  DATA G
260 K1=(D[1,2]+D[J,2])/2
270 K2=(D[1,3]+D[J,3])/2
280 K3=(D[1,4]+D[J,4])/2
290 K4=(D[1,5]+D[J,5])/2
300 FOR N=2 TO J-1
310 X[N-1,1]=D[N,1]
320 X[N-1,2]=(D[N,2]-K1)*Z/0.1084
330 X[N-1,3]=D[N,3]-K2
340 X[N-1,4]=D[N,4]-K3
350 X[N-1,5]=D[N,5]-K4
360 NEXT N
370 FOR N=1 TO J-2
380 L[1,1]=X[N,3]-T[N,3]
390 L[2,1]=X[N,4]-T[N,4]
400 L[3,1]=X[N,5]-T[N,5]
410 MAT Y=A*L
420 X[N,3]=Y[1,1]/(X[N,2]*S1)
430 X[N,4]=Y[2,1]/(X[N,2]*S1)
440 X[N,5]=Y[3,1]/(X[N,2]*S1*C1)
450 NEXT N
```

```
640 DISP "ENTER WING ON RUN FILE #";
650 INPUT G
660 LOAD  DATA G
670 K1=(D[1,2]+D[J,2])/2
680 K2=(D[1,3]+D[J,3])/2
690 K3=(D[1,4]+D[J,4])/2
700 K4=(D[1,5]+D[J,5])/2
710 FOR N=2 TO J-1
720 C[N-1,1]=D[N,1]
730 C[N-1,2]=(D[N,2]-K1)*Z
740 C[N-1,3]=D[N,3]-K2
750 C[N-1,4]=D[N,4]-K3
760 C[N-1,5]=D[N,5]-K4
770 NEXT N
780 FOR N=1 TO J-2
790 L[1,1]=C[N,3]-V[N,3]
800 L[2,1]=C[N,4]-V[N,4]
810 L[3,1]=C[N,5]-V[N,5]
820 MAT Y=A*L
830 C[N,3]=Y[1,1]/(C[N,2]*S1)
840 C[N,4]=Y[2,1]/(C[N,2]*S1)
850 C[N,5]=Y[3,1]/(C[N,2]*S1*C1)
860 NEXT N
870 PRINT "CORRECTED DATA OF RUN #"R1
880 DISP "INPUT WALL CORR'N-DRAG";
890 INPUT B
900 DISP "ENTER WALL CORR'N-AOA";
910 INPUT F
911 DISP "ENTER HEIGHT ABOVE TRUNNION (FT)";
912 INPUT H
```

```
920 FOR N=1 TO J-2
930 A1=C[N,1]/57.3
940 D[N,3]=C[N,3]-X[N,3]
950 D[N,4]=(C[N,4]-X[N,4])+B*D[N,3]↑2
960 D[N,5]=(C[N,5]-X[N,5])+(D[N,3]*H*SIN(A1)+D[N,4]*(1.166-H*COS(A1)))/C1
970 D[N,1]=C[N,1]+F*D[N,3]
980 D[N,2]=C[N,2]
990 NEXT N
1000 PRINT "ROW #"TAB8"AOA(DEG)"TAB18"Q(PSF)"TAB30"CL"TAB40"CD"TAB48"CM-C/4"
1010 FOR N=1 TO J-2
1020 WRITE (15,1300)N,D[N,1],D[N,2],D[N,3],D[N,4],D[N,5]
1030 NEXT N
1040 DISP "CHECK DATA,PRESS (CONT-EXEC)";
1050 STOP
1060 DISP "ENTER FILE # FOR REDUCED DATA";
1070 INPUT Z
1080 STORE  DATA Z
1090 PRINT "RUN #"R1"REDUCED DATA IS STORED IN FILE #"Z" "
1300 FORMAT 2X,F3.0,1X,F8.4,2X,F8.4,3X,F7.4,3X,F7.4,3X,F7.4
1400 GOTO 237
1410 END
```

PROGRAM C(a)

MODIFICATION TO COMPUTE AERODYNAMIC TARES

```
870 PRINT "AERODYNAMIC TARES OF RUN #"R1
880 DISP "INPUT WALL CORR'N-DRAG";
890 INPUT B
900 DISP "ENTER WALL CORR'N-AOA";
910 INPUT F
911 DISP "ENTER HEIGHT ABOVE TRUNNION (FT)";
912 INPUT H
920 FOR N=1 TO J-2
930 A1=C[N,1]/57.3
940 D[N,3]=C[N,3]-X[N,3]
941 W[N,3]=-X[N,3]
950 D[N,4]=(C[N,4]-X[N,4])+B*D[N,3]↑2
951 W[N,4]=-X[N,4]
960 D[N,5]=(C[N,5]-X[N,5])+(D[N,3]*H*SIN(A1)+D[N,4]*(1.166-H*COS(A1)))/C1
961 W[N,5]=-X[N,5]
970 D[N,1]=C[N,1]+F*D[N,3]
980 D[N,2]=C[N,2]
990 NEXT N
1000 PRINT "ROW #"TAB8"AOA(DEG)"TAB18"Q(PSF)"TAB29"DCL"TAB39"DCD"TAB47"DCM-C/4"
1010 FOR N=1 TO J-2
1020 WRITE (15,1300)N,D[N,1],D[N,2],W[N,3],W[N,4],W[N,5]
1030 NEXT N
1040 DISP "CHECK DATA,PRESS (CONT-EXEC)";
1050 STOP
1060 DISP "ENTER FILE # FOR REDUCED DATA";
1070 INPUT Z
1080 STORE  DATA Z
1090 PRINT "RUN #"R1"REDUCED AERO TARES ARE STORED IN FILE #"Z" "
1300 FORMAT 2X,F3.0,1X,F8.4,2X,F8.4,3X,F7.4,3X,F7.4,3X,F7.4
1400 GOTO 237
1410 END
```

# REFERENCES


1. Concannon, M. J., Design Study of a Strain Gauge Wind Tunnel Balance, M.S. Thesis, Naval Postgraduate School, Monterey, March 1974.

2. Casko, J. D., A Microprocessor Controlled Automatic Data Logging System - (ADL), M. S. Thesis, Naval Postgraduate School, Monterey, June 1977.

3. Heard, C. A., Wind Tunnel Wall Corrections for Arbitrary Planforms and Wind Tunnel Cross-sections, M.S. Thesis, Naval Postgraduate School, Monterey, June 1977.

4. Pope, A. and Harper, J. J., Low-speed Wind Tunnel Testing, Wiley, 1966.

5. Dommasch, D. O., Sherby, S. S., and Connolly, T. F., Airplane Aerodynamics, Pitman, 1967. Pg. 49-53.

6. Abbott, I. H. and vonDoenoff, A. E., Theory of Wing Sections, McGraw-Hill, 1949. Pg. 336, 510.

7. Etkin, B., Dynamics of Flight Stability and Control, Wiley, 1959. Pg. 448.

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